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COHERENT-OPTIC PROCESSOR FOR SPACE-AND-TIME PROCESSING OF ANTENNA-ARRAY SIGNALS

Kiev IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOELEKTRONIKA in Russian No 2, Feb 81 pp 27-33

[Article by A. Yu. Grinev, V. N. Osinskiy, Ye. N. Voronin, L. L. Vrublevskiy, V. S. Temchenko, S. A. Malyshev, and A. A. Rymov]

[Text] This article examines antenna arrays which produce beam patterns through coherent-optic methods and which retain time information at the processor's output for subsequent processing. It discusses equipment for the input and the output of information and presents the results of experimental research.

Antenna arrays with coherent-optic processing of a received space-and-time signal are promising systems for solving a number of problems in radar, radio-astronomy and sonar detection [1-4]. The basic elements of such systems are a device for leading in signals received by the transducers of the antenna array to the optical processor (a space-and-time light modulator) and a device for leading the processed space-and-time information away from the processor's output and into a scanning photographic recorder or a multielement photodetector.

This article discusses specific types of input and output equipment and experimentally investigates one of the processor variants which makes it possible to produce beam patterns of two-dimensional antenna arrays while retaining time (non-coordinated) information for subsequent processing by traditional methods (including coherent-optic).

Space-and-Time Light Modulators

Multiplexing acousto-optical [2,5,6], electronically addressed (see [25,28] in [2]), membrane (see [26] in 2) as well as multiplexing (mosaic, matrix) light modulators based on the electro-optical effect [7] can be used as space-and-time light modulators.

Acousto-optical space-and-time light modulators make it possible to combine a great many (50-100) parallel channels for processing, each of which can operate at frequencies of 1 GHz or better (5-6 GHz frequencies are planned) and can possess bandwidths greater than 100 MHz (up to 1 GHz). They do possess, however, certain shortcomings: they are difficult to realize if the number of channels is greater than

100; they are poorly suited for the processing of two-dimensional antenna-array signals (although gearing-up with respect to time makes it possible to overcome this difficulty, it makes the electronic portion of the system extremely complex [2]); and they do not allow one to process signals of more than 70-100 μ s duration (this time can be increased several times over through the use of multipath delay lines, which considerably complicates the system). This last fact limits the resolution with respect to frequency to a few dozen kilohertz (depending upon the range of working frequencies) [3-6,8].

When electronically addressed space-and-time light modulators are employed, the realization of two-dimensional direction-finding and the processing of signals with frequencies of more than 10 MHz is impeded. A high control voltage and complicated address equipment are necessary.

In the case of a membrane space-and-time light modulator, element-by-element control is impeded, light losses are great and the speed of response is limited.

Space-and-time light modulators based on the electro-optical effect in crystals (LiTaO_3 and LiNbO_3 , for example) make it possible to construct more than 100 parallel channels and, in the case of special unitizing, form a two-dimensional structure. They have the potential to occupy a band greater than 1 GHz. Belonging to the shortcomings of such modulators are: the recovery of noncoordinate information is possible only with coherent throughput (optical heterodyning); the large value for the half-wave voltage-- $U_{\lambda/2} \geq 50$ V (there are known methods for reducing $U_{\lambda/2}$ to less than 10 V); and the formation of spatial directivity patterns is problematic for the reception of broadband signals.

Multielement Photodetectors

For radar problems, the most promising devices for registering optical signals at the processor's output are multielement photodetectors (photodetector matrices and rules) which make it possible to accomplish a parallel recovery of processed space-and-time information. Multielement photodetectors are made basically from silicon whose spectral response encompasses the range from 0.4 to 1.0 μ m and whose manufacture at the present time is the most developed.

The photodetector matrix is a collection of photosensitive components which, together with the commutating elements, form the cells of the matrix. With the help of vertical and horizontal buses, the cells are organized into columns and lines in such a manner that each cell of the matrix is located at the intersection of the address buses. The photodetector rule has one line and has simpler functional capabilities in comparison to the matrix.

Photodiodes, phototransistors as well as charge-coupled devices (CCD's) can be employed as photosensitive structures. The basic parameters characterizing the multielement photodetector are its spatial resolution, spectral and threshold sensitivity and speed of response.

The spatial resolution of the registration system in this case is determined by the resolving power of the optics employed, by the sensitivity requirements of the multielement photodetector and by the IM distortion which is dependent upon the

interaction between the photosensitive elements. The spatial resolution is also dependent upon the technological feasibilities [13]. Depending upon the method of preparing multielement p-n photodetectors, their resolving power comprises 10 to 20 lines per millimeter. The use of CCD structures makes it possible to increase the resolving power of multielement photodetectors to 40 or 50 lines per millimeter.

In acousto-optical spectrum-analyzer systems for radioastronomy, it is expedient to employ CCD multielement photodetectors [4] which operate in the charge-accumulation mode and possess high sensitivity to weak light flux (less than 10^{-7} W) and high element density (spaced less than 20 μm). They also make it possible to use them as an interface buffer between the optical and digital systems. These devices, however, are characterized by prolonged charge accumulation (more than 1 μs) and do not permit the parallel recovery of information.

Owing to the increased light flux, phototransistor matrices possess a higher spectral sensitivity than photodiode matrices. There exist several methods of arranging phototransistor-based matrices. These methods are well presented in the corresponding literature [14]. It should be noted that a drawback of phototransistor multielement photodetectors is their slow response (less than 10 MHz).

In order to achieve a high response speed, the use of multielement photodetectors whose photosensitive elements are diodes appears promising [10-12].

Individual cells of the photodiode matrices possess a high threshold sensitivity (2×10^{-14} J) and a high response speed ($\tau_{\phi} \sim 25$ ns) [12]. This figure can be reduced to a few tenths of a nanosecond [15] through the use of avalanche amplification of the light flux. However, their arrangement in matrices does not allow one to realize the maximum threshold sensitivity as a result of the presence of strong pulse IM interference, while the maximum response speed is limited by the inherent R-C parameter of the matrix.

Description of the Experimental Unit.

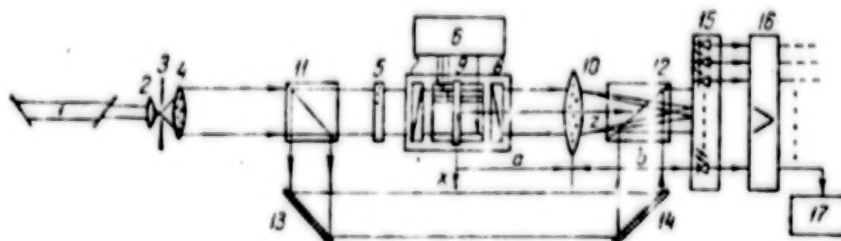


Fig. 1. Block diagram of experimental unit

All experimental research has been conducted on a unit whose block diagram is presented in fig. 1. It includes a He-Ne laser 1; a collimator consisting of a microscope objective 2, a diaphragm 3 and lens 4; a cylindrical lens 5 ($f = 0.5$ m); a compressive flux of the corresponding size; a simulator 6 of the signal from a 16-element antenna array; a polarizer 7 and analyzer 8; an electro-optical element 9; and objective 10 ($f = 0.6$ m) and beam splitters 11 and 12; mirrors 13 and 14; a

multielement linear photodetector of integrated design 15; a multichannel amplifier 16; and a registration device 17. The antenna-array simulator 6 includes master oscillators (corresponding to individual radio sources), a 16-channel amplifier with independent control of the amplitude (from 0 to 50 dB) and phase (from 0 to 360°) of the signals. It makes it possible to simulate any combination of signals from a linear 16-element antenna array at intermediate frequencies of 100 and 200 kHz. The electro-optical element 9 of the modulator consists of two identical plates (16 x 8 x 0.5 mm) of lithium tantalate monocrystal of 90° cut upon which 32 parallel electrodes 250 μm wide and 400 μm apart are deposited. A half-wave plate 10 is installed between these plates for thermal compensation. The half-wave voltage of the space-and-time light modulator is 70 ± 5 V.

A common p-n silicon photodiode structure forms the basis of the design of the multielement photodetector used in the experimental unit. The p-type regions have been created using the diffusion of boron in the silicon substrates. A row of photodiodes of 59 elements with a spacing of 175 μm is located on a crystal of dimensions 5.6×10 mm². The dimensions of the photosensitive area of one element are 70 x 5000 μm².

The spectral sensitivity of the multielement photodetector was equal to 0.18 A/W at a wavelength of 0.63 μm. The speed of spectral sensitivity values for the components did not exceed ± 1%. The dark currents of the photosensitive elements were within limits of $(5-8) \times 10^{-9}$ A. The maximum threshold sensitivity of this photodetector amounted to a value of 0.3×10^{-12} W x Hz⁻¹. The response speed of the registration device for the optical signal was measured using the rise time of the pulse's leading edge and amounted to a value of approximately 10 ns for a 75Ω load.

Results of Experimental Research

The aim of the experiment was: 1) the formation of an angular spectrum of radio emission in the presence of one or two radio sources [16]; 2) the suppression of a conjugate image using the equivalent lens method [17]; and confirmation of the feasibility of spatial extraction of output information with the help of a multielement linear photodetector in the heterodyne detection mode, making it possible to recover noncoordinate information.

1. Forming the Angular Spectrum

The processor's output diffractogram (in the plane of the multielement linear photodetector in fig. 1) is a superposition of the zero order of diffraction (the parasitic illumination resulting from the operational mode of the multielement linear photodetector) and the ± first orders of diffraction, collectively conjugate and centrally symmetrical relative to the processor's axis. With respect to power, the intensity of these first orders of diffraction is proportional to the two-dimensional convolution of the angular power spectrum from the received r.f. emission with the radiation pattern of the antenna array (when the space-and-time light modulator is operating in the nonlinear mode, the appearance of higher orders of diffraction is also possible) [16,17]. In the case of reception of emissions from point radio sources, the latter are represented in the form of diffraction spots with distributed intensity. This distribution is coincident with the radiation pattern with respect to power. The position of the maximum of these spots determines the coordinates of the radio sources.

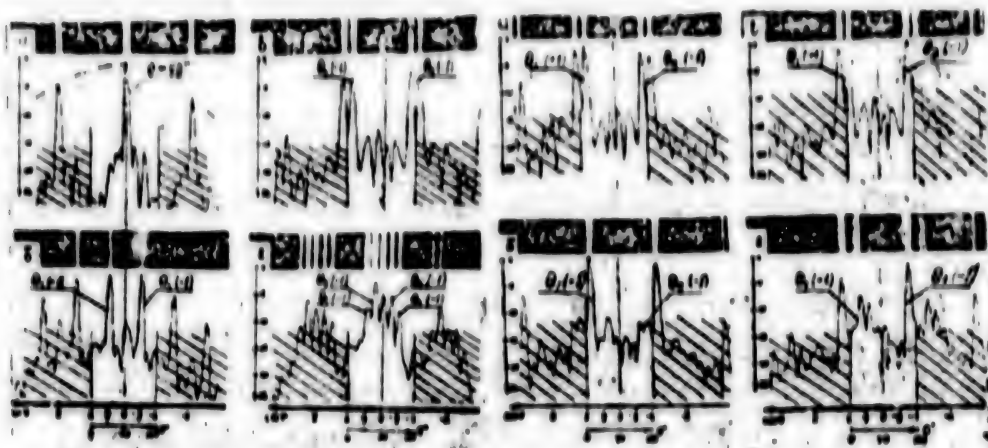


Fig. 2. Images of point radio sources: *a* - one radio source ($\theta = 90^\circ$); *b* - one radio source ($\theta_1 = 60^\circ$) and conjugate image ($\theta_2 = 120^\circ$); *c* - one radio source ($\theta_1 = 30^\circ$) and conjugate image ($\theta_2 = 150^\circ$); *d* - two radio sources ($\theta_1 = 60^\circ$, $\theta_2 = 75^\circ$) and their conjugate images ($\theta_3 = 120^\circ$, $\theta_4 = 105^\circ$).

Fig. 3. For the equivalent lens method: *a* - one radio source ($\theta_1 = 30^\circ$) and conjugate image ($\theta_2 = 150^\circ$); *b* - suppression of the conjugate image ($\theta_2 = 150^\circ$) by a convex equivalent lens with $f = 12$ m; *c* - suppression of the image ($\theta_1 = 30^\circ$) by a concave equivalent lens with $f = 24$ m; *d* - suppression of the image ($\theta_1 = 30^\circ$) with a concave equivalent lens with $f = 6$ m.

In each of the figures in 2 are shown photographs of the output diffractogram (top) and the results of its photometric evaluation (below) for the various positions of one (*a*, *b*, *c*) and two (*d*) radio sources. In this case, elements 11-14 (fig. 1) were not employed. As can be seen from the results of the photometric evaluation, the output picture is weighted with an envelope in the form of a radiation diagram pupil of the space-and-time light modulator channels (crosshatch in fig. 2, *a*). The output picture is also periodic as a result of the equidistant spacing of the light modulator channels (only three periods are shown). The x-coordinate axis is graduated with an equally spaced scale of the direction cosine ($\cos \theta$). The region of the actual angles $|\cos \theta| \leq 1$ is given in degrees, the angle θ being calculated from the axis of the linear antenna array (the region of the imaginary angles is crosshatched). In the given experiment, the processor produces a radiation pattern in the form of: $\sin^2(N\psi)/\sin^2\psi$, $\psi = Kd\cos\theta/2$, where $N = 16$ (the number of antenna-array elements), d is the antenna-array spacing and $K = 2\pi/\lambda$ (the wave number, $d/\lambda = 0.5$). Since the two-terminal network amplitude (16, 17) of the light modulator is used, the output picture (fig. 2, *b*, *c*, *d*) is reproduced in the form of symmetrical \pm first orders of diffraction. The zero order of diffraction is described using the same expression as the radiation pattern and is suppressed here (fig. 2, *b*, *c*) owing to the balanced operation of the light modulation (all of the light modulator's channels are attenuated in the absence of a signal).

2. Defocusing (Suppression) of the Conjugate Image Using the Equivalent Lens Method

The presence of conjugate images (fig. 2) leads to a two-valued determination of the radio source's coordinates (0 or $180^\circ - \theta$). Its elimination is possible by use of one of the methods noted in [17]. The most effective is the method of an equivalent lens realized at the level of the antenna array from segments of the feeder, from phase-shifters, etc. In accordance with [17], an equivalent lens can be constructed which is a collecting lens for the \pm first order of diffraction and a diverging lens for the \pm first order. The shorter its focal length f_e , the more the conjugate image diverges. If the space-and-time light modulator has the dimensions $\Delta x = 16$ mm, $\lambda = 0.63$ μ m and $f_e = 1$ m, its suppression will amount to approximately -30 dB. The effect of the light modulator's pupil in a lensless processor [17], however, makes it necessary to satisfy the requirement $\delta x \leq 0.1\lambda f_e / \Delta x$ (δx is the pupil diameter of the modulator channels). This requirement permits interpolation of the radiation pattern of the modulator channel pupils at a level that insures the undistorted reconstruction of the r.f. angular spectrum throughout the image's entire zone. In this case, $\delta x = 100$ μ m (given as an example of an aperature mask), $\Delta x = 8$ mm, $\lambda = 0.63$ μ m. Thus, from the latter requirement, it follows that $f_e \geq 12$ m.

In fig. 3, *a* are shown the primary and conjugate images at the output of a non-reduced Fourier processor. If a convex equivalent lens with $f_e = 12$ m is used, the first order will be suppressed by -12 dB (fig. 3, *b*) in accordance with [17]. An auxiliary lens ($f' = 0.6$ m) is used to shorten the 12 m length of the unit. The distances f_1 , f_2 , a and b (fig. 1) were selected from the condition $1/(f_1 - a) + 1/f_2 = 1/b$. In fig. 3, *c*, *d* are shown diffractograms obtained with concave equivalent lenses with $f_e = 24$ m (suppression of the conjugate image is approximately -9 dB) and $f_e = 6$ m, respectively. We will here note that if $f_e = 6$ m and if the above-mentioned requirement is satisfied, the suppression of the conjugate image would achieve the level of -15 dB. As a result of the pupil effect, however, the requirement is violated and the expected level is not achieved (fig. 3, *d*).

3. Heterodyne Photodetector Operation

If a complex radio signal undergoes coherent-optic processing using the processor examined above, it will be necessary to accomplish the coherent extraction mode in order to retain complete information about its amplitude, frequency and phase (heterodyne photodetection) [18]. The simplest arrangement of such extraction is shown in fig. 1. In fig. 4 are shown oscillograms of the signal spectrum at the modulator input *a* (a) and at the space-and-time light modulator's output in the optical heterodyning mode (b).

In order to illustrate the feasibility of extracting spatial information with the aid of a space-and-time light modulator, fig. 5 presents the result of photometric interpretation of the output diffractogram from a single radio source (see fig. 2, *a*) reproduced by means of an automatic recorder using an FEU-28 (solid curve). It also shows a sample of this diffractogram obtained at the outputs of the light modulator's elements.

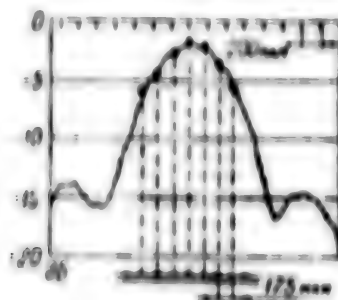


Fig. 5. Output diffractogram from a single radio source

Thus, the investigation which has been carried out and the results of experimental studies point out the feasibility of constructing spatial directivity patterns for two-dimensional antenna arrays while retaining the time (noncoordinate) information for its subsequent processing by traditional methods (including coherent-optic).

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CNO: 1860/237

UDC 621.372.826

EXCITATION OF A SEMI-INFINITE DIELECTRIC PLATE FROM THE OPEN END OF A PLANAR DIELECTRIC WAVEGUIDE

Kiev IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOELEKTRONIKA in Russian Vol 24, No 2, Feb 81 pp 60-65 manuscript received 21 Nov 79, after revision 21 Apr 80

VASIL'YEV, Ye. N., POLYNKIN, A. V. and SOLODUKHOV, V. V.

[Abstract] With its open end a planar dielectric waveguide faces a semi-infinite dielectric plate in the same plane and at some angle. The two-dimensional problem of determining the excitation of the plate when a surface H-wave enters the open end of the waveguide is solved by the method of integral equations for the surface currents in a Cartesian system of coordinates. The solution is found as the sum of two components, a uniform one and a nonuniform one. The former represents the surface currents of nondecreasing eigenmodes; the latter represents the effect of an irregular field structure and decreases fast with increasing distance from it. As a typical example, the passage of an even surface wave through a gap of a certain width in a single-mode waveguide is considered. Figures 4; references 5: 3 Russian, 2 Western (both in translation).

[236-2415]

UDC 621.375.126

STRUCTURE OF A MODULE IN ACTIVE PHASED CENTIMETER-WAVE ANTENNA ARRAY BASED ON AVALANCHE-TRANSIT-TIME DIODES

Kiev IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOELEKTRONIKA in Russian Vol 24, No 2, Feb 81 pp 88-91 manuscript received 26 May 80

DAVYDOVA, N. S.

[Abstract] Avalanche-transit-time diodes and electron-transfer diodes are the most practical devices for modules of active phased centimeter-wave antenna arrays. Here two structural variants of such a module with all diodes of the same type are considered. In the first variant the input stage operates in the optimum mode and the supply currents in all stages are equal. In the second

variant all stages operate in their optimum modes, and the supply current becomes smaller from one stage to the next. Both variants are compared to the number of stages necessary for realizing a given gain, the small-signal gain, and the efficiency of the module at a given output power. The analysis reveals that, while the first variant yields a much higher gain with a fixed number of stages, the second variant offers a higher efficiency. Calculations show that an efficiency of 10% is attainable with typical avalanche-transit-time diodes, not counting the losses in the circulator, and a 30 dB gain is realizable with seven stages in the second variant. Figures 4; references 4: 1 Russian, 3 Western (1 in translation). [236-2415]

UDC 621.391.26

ELIMINATING THE AMBIGUITY OF MEASUREMENT OF DISTANCE IN COHERENT RADIO SYSTEMS WITH LONG BASES

Kiev (ZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOELEKTRONIKA in Russian Vol 24, No 1, Jan 81 pp 29-34 manuscript received 22 Oct 79

KREMER, I. Ya. and PETROV, V. M.

[Abstract] The possibility of using random placement of the elements of an antenna array to eliminate ambiguity in the reading of distance during processing of signals with specific wave fronts is analyzed. The number of array elements required for unambiguous measurement of distance and for resolution of sources as to their range is determined. The level of the side lobes of the autocorrelation function for range is estimated. It is found that the mean value of the autocorrelation function for the range of an array with remote elements coincides with the autocorrelation function for an equidistant array. If the probability that the side lobes will exceed a given level within a fixed band of range coordinates is fixed, equation (11) presented in this article allows the number of elements of the nonequidistant antenna array to be determined. The boundaries of applicability of the equation produced are investigated. The equations presented permit calculation of the number and location of array elements for a given side lobe level of the range autocorrelation function. Figures 4, tables 2; references 6: 5 Russian, 1 Western. [230-6308]

CHARACTERISTICS OF PRINTED-CIRCUIT RADIATORS IN PLANAR PHASED ANTENNA ARRAYS

Kiev IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOELEKTRONIKA in Russian Vol 24, No 2, Feb 81 pp 41-48 manuscript received 6 Jun 80

FILIPPOV, V. S.

[Abstract] A printed-circuit radiator in a planar phased antenna array is considered which consists of metal plates above a metal shield on a thin dielectric substrate, with antiphase excitation of all stub pairs for maximum radiation in the direction normal to the plane of the shield. It is fed through a coaxial tee and a coaxial half-wavelength waveguide segment, with the coupling holes assumed to be so small that only the stub current is determined by the field in them. The complex power is calculated by the energy method, the operator equation of the first kind with respect to the current in a metal plate being transformed into a system of linear algebraic equations according to the method of finite elements and with piecewise-polynomial approximation. The radiation pattern is assumed to be proportional to the $m = n = 0$ space harmonic of the normal electric field when all other radiators in the array are under matched loads. The input resistance of such a radiator with just one circular plate above the shield is calculated as a function of the plate diameter and as a function of the distance between stubs. Typical results are shown for this radiator with a dielectric ($\epsilon = 2.56$) layer of various thicknesses in a rectangular array with equal pitches $d_x = d_y = 0.6\lambda$ along both coordinates. Figures 4; references 8: 2 Russian, 6 Western (four in translation). [236-2415]

UDC 621.396.67

HIGH-POWER MICROWAVE AMPLIFIERS IN ACTIVE ANTENNA ARRAYS

Kiev IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOELEKTRONIKA in Russian Vol 24, No 2, Feb 81 pp 86-88 manuscript received 26 May 80

GRANOVSKAYA, R. A. and KUZ'MINA, G. A.

[Abstract] Active elements in active phased transmitter antenna arrays must provide an average power which ranges, depending on the particular application, from tenths of a watt to hundreds of watts. Here the various technical requirements are reviewed which microwave amplifiers for such antennas must meet. The characteristics of vacuum-tube devices (klystrons, M-type and O-type traveling-wave tubes) and semi-conductor devices (transistors, avalanche-transit-time diodes, Gunn-effect diodes) are compared for purposes of selection in order to meet specific requirements. Figures 2; references 6: 2 Russian, 4 Western (3 in translation). [236-2415]

EFFECT OF THE AMBIENT MEDIUM ON THE CHARACTERISTICS OF AN ANTENNA IN THE FORM OF A CHAMFERED OPEN WAVEGUIDE END WITH A FLANGE

Kiev IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOELEKTRONIKA in Russian Vol 24, No 2, Feb 81 pp 111-112 manuscript received 2 Jan 80

VASIL'YEV, Ye. N. and KOSOVA, T. A.

[Abstract] An important parameter of an antenna in the form of a chamfered open waveguide end with a flange is the reflection coefficient for the fundamental mode. This reflection coefficient is directly related to the densities of the equivalent electric and magnetic currents. Both current densities, solutions to the integral equations of the waveguide problem, depend on the dielectric permittivity ϵ_2 of the ambient medium. The reflection coefficient was calculated on the basis of this relation for an empty waveguide ($\epsilon_1 = 1$) with a distance $h = 0.72\lambda$ between opposite walls. The magnitude of the reflection coefficient is maximum when $\epsilon_2 = 1$, when losses in the dielectric medium give rise to additional reflections at the boundary between both media. The reflection coefficient also depends on the chamfer angle, which provides the possibility of matching such an antenna to the ambient medium and to hold the reflection coefficient within a given permissible upper limit. Figures 2; references: 1 Russian. [236-2415]

ADAPTIVE DOME ANTENNA ARRAY

Kiev IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOELEKTRONIKA in Russian Vol 24, No 2, Feb 81 pp 94-97 manuscript received 18 Feb 80, after revision 28 Apr 80

SAMOYLENKO, V. I. and GRUBRIN, I. V.

[Abstract] The main feature of a dome antenna is that the lens curves the plane front of directional interference signals. This complicates the design for the optimum radiation pattern, which requires calculating the necessary phases of the radiators. Here the method of geometrical optics is applied to such an antenna, the waves from each radiator propagating along paths which require the minimum travel time, so that the phases of the radiators as well as the phase leads of directional interference signals in the radiators can be determined. An adaptive dome antenna was accordingly simulated on a digital computer. The generalized signal-to-noise ratio served as the adaptation quality criterion, and white intrinsic noise as well as narrow-band interference were included in the model. Results are shown for a 21-element array of equidistant ($d = 0.5\lambda$) isotropic radiators under a dome, with an $L/R_0 = 1.4$ ratio of array length to dome radius. The results indicate an improved performance, especially in the case of two closely spaced interference sources. Figures 2; references 8: 4 Russian, 4 Western. [236-2415]

OPTIMIZATION OF THE RADIATION PATTERN OF AN ANTENNA WITH MOVING AND DEFORMING SHADED REGIONS IN ITS APERTURE

Kiev IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOELEKTRONIKA in Russian Vol 24, No 2, Feb 81 pp 79-85 manuscript received 21 Nov 79, after revision 29 May 80

KHURGIN, I. M.

[Abstract] A directional antenna is considered with moving and deforming shaded regions in its plane aperture which are caused by other antennas or devices under the radome. The field distribution in this aperture is sought which will minimize the level of the largest side lobe in the radiation pattern with every possible position and shape of these shaded regions. The field distribution with respect to the two coordinates in the plane is treated as a product of two distributions, one with respect to each coordinate only. In an important practical case one of these distributions is fixed and the other is to be optimized. This minimax problem reduces to linear programming in the case of a symmetric aperture with a real radiation pattern. It reduces to nonlinear programming in the case of an asymmetric aperture with a complex radiation pattern or, which is simpler, to linear programming of an equivalent simultaneous minimization of the maximum modulus of the real part and that of the imaginary part. The problem is solved by the method of partial regions, rectangular or circular, with the optimizable one-coordinate field distribution sought in the form of a finite complex Fourier series. For illustration, this method is applied to the simple case of a rectangular aperture and a rectangular shaded region with correspondingly parallel sides and moving along one coordinate only. Figures 4; references: 5 Russian. [236-2145]

DESIGN OF LOW-Q RESULTANT WAVE ANTENNAS ON THE BASIS OF A STRIP TRANSMISSION LINE BY THE METHOD OF SUCCESSIVE APPROXIMATIONS

Kiev IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOELEKTRONIKA in Russian Vol 24, No 1, Jan 81 pp 40-45 manuscript received 26 Feb 79, after revision 22 Nov 79

TERESHIN, O. N. and KORNYUKHIN, V. I.

[Abstract] The possibility is studied of creating a method for design of antennas without requiring the use of antennas with large angles of radiation, because this reduces the directionality of the antenna and causes reflection from the ends of the antenna. It is concluded that a condition of pure reactance of the load impedance places no limitations on the amount of delay of the surface wave, eliminating the problem. A two-dimensional periodic structure with capacitive load based on the open sectors of a two-wire line is shown. An equation is presented for selecting the length of the wire sections, the distance between them

and the diameter of the wire. The method allows the electrical and geometric parameters of short antennas for large radiation angles to be selected on the basis of the assigned characteristics of the radiated field. Figures 5; references: 4 Russian.
[210-6508]

UDC 621.396.677

MATHEMATICAL SIMULATION OF WAVEGUIDE ANTENNA ARRAYS WITH FINITE DIMENSIONS

Kiev IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOELEKTRONIKA in Russian
Vol 24, No 2, Feb 81 pp 33-41 manuscript received 26 May 80

GOSTYUKHIN, V. L., GRINEVA, K. I., KLIMACHEV, K. G. and TRUSOV, V. N.

[Abstract] A mathematical model of a waveguide antenna array with a finite number of radiator elements can be constructed by two methods. The first method involves solving the electrodynamical boundary-value problem for the whole antenna curtain. The corresponding integrodifferential equation for the unknown tangential electric field component in the aperture is reduced to a system of linear algebraic equations according to the Galerkin method and the resulting matrix is then inverted according to the standard Gauss method, its elements being determined solely by the array structure and not depending on the excitation mode, whereupon the antenna characteristics within the scanning sector are calculated. According to the second method, one calculates first the coefficients of mutual coupling between radiator elements and then, by superposition, the reflection coefficients in the waveguide and the field amplitude-phase distribution in the aperture. The fast Fourier transformation is helpful here. For a medium-size array the procedure can be simplified in two ways, either by reducing the problem to one of an array with a small number of radiators and thus with mutual coupling between only a few radiators, or by increasing the distance between radiators and thus weakening the coupling between them while increasing the number of radiators, heuristically, so that an array with an equivalent central region will result. The various algorithms have been programmed in FORTRAN-4. The computer requirements for up to 11×11 large arrays and typical numerical results are presented. Figures 4; tables 1; references 7:
5 Russian, 2 Western.
[236-2415]

ELECTRODYNAMIC ANALYSIS OF A REFLECTOR MADE OF A METAL MESH

Kiev IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOELEKTRONIKA in Russian Vol 24, No 2, Feb 81 pp 109-111 manuscript received 30 Aug 79, after revision 15 Apr 80

VYAKHIREV, N. I. and YATSKEVICH, V. A.

[Abstract] Reflectors in the form of dense meshes of thin conductors are often used, especially in short-wave systems, for suppressing the radiation in a certain direction. Here a design method is proposed which involves the solution of an integrodifferential equation which takes into account diffraction by the reflector and also the penetration of electromagnetic waves through the mesh. This equation for the current density is solved numerically by the method of moments, with a system of piecewise-sinusoidal basis functions and step functions as the projection system. The solution is found to converge faster than one obtained by the matching method. The shielding effect of such a reflector was calculated in the near field for a configuration simulating a two-dimensional electric vibrator near the reflector. The results indicate that the field can be weaker with a mesh of conductors spaced at a distance $d/\lambda = 0.02-0.06$ than with a solid reflector. This phenomenon is attributed to the peculiar amplitude and phase relation between diffracted waves. Figures 2; references 4: 3 Russian, 1 Western (in translation).

[236-2415]

UDC 621.677.49:621.396.967.7

RADIOOPTICAL ANTENNA ARRAYS (REVIEW)

Kiev IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOELEKTRONIKA in Russian Vol 24, No 2, Feb 81 pp 15-26 manuscript received 15 Apr 80

GRINEV, A. Yu.

[Abstract] Radio-optical antennas are characterized by receiver operation in the microwave range and signal processing in the optical range. The analysis of these devices combines radio engineering and spectral methods, most important being the shaping of the space directional diagram. Problems in making such antennas suitable for radar applications range from those easily solved by conventional methods to those requiring nonconventional approaches such as wide-angle scanning over a wide frequency range. Here the basic theoretical principles and algorithms of shaping a directional diagram of planar, piecewise-planar and nonplanar antenna arrays by coherent-optics methods are reviewed. Related topics include reproduction of the frequency-angle spectrum of radiation with the aid of a linear antenna array, the performance of antenna arrays depending largely on the type of space-time light modulator used, and the effects of discreteness of antenna arrays. The

feasibility of using radio-optical antennas depends on their characteristics such as gain, dynamic range, processor accuracy, and resolution, as well as distortion correcting features. The use of fiber-optic components and digital signal processing with optoelectronic devices are two interesting possibilities. Figures 3; references 37: 34 Russian, 3 Western (two in translation).
[236-2415]

UDC 621.396.677.83

SLIT SHIELD FOR FIELD SUPPRESSION OVER A WIDE-ANGLE SECTOR IN A GIVEN PLANE

Moscow *RADIOTEKHNIKA* in Russian No 2, Feb 81 pp 76-78
manuscript received after completion 7 Jan 80

MEL'NIKOV, Yu. M., MOSHKOV, V. A. and PETROVA, V. G.

[Abstract] A shield for shading an antenna is described with suppresses side lobes in one plane, usually horizontal, of the radiation pattern. The basic concept is a long opaque strip with a parallel slit through the middle, the field at its lateral edges being compensated by the field passing through the slit. The effectiveness of such a shield is limited by its finite length and by its distance from the antenna. Only with an increasing distance does the suppression zone widen, but such a configuration leads to technical difficulties and can become impractical. This problem is solved by a wider shield with two additional slits, on both sides of and symmetrical with respect to the middle slit. The design of such a shield with a shifted compensation pattern is based on calculations by the Kirchhoff method for a scalar field in the Fresnel zone. An experimental shield built according to this principle and placed before the open end of a waveguide-radiator with E polarization yielded a radiation pattern close to the theoretical pattern of an infinitely long shield. Figures 4;
references: 4 Russian.
[240-2415]

UDC 621.396.677.494

MULTIFREQUENCY SCANNING ANTENNA ARRAYS (REVIEW)

Kiev *IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOELEKTRONIKA* in Russian Vol 24, No 2, Feb 81 pp 4-15 manuscript received 7 May 80

VOSKRESENSKIY, D. I. and PONOMAREV, L. I.

[Abstract] Electrically scanning phased antennas offer the possibility of high-speed multifunctional control, but their cost is high and their range of operating frequencies is limited. The problem of plotting directional diagrams independently and simultaneously at several frequencies in different bands with the same aperture is particularly important in the development of satellite radar systems and in

radio countermeasure systems with size limitation. It is shown here that the advantage of multifrequency antennas over broadband antennas is that all the difficulties associated with wideband components do not arise, while the frequencies can span several octaves. Various configurations of compound antennas have been proposed for achieving this. A dual-frequency antenna consists of two arrays, a vibrator or slot array above an arbitrary type of array, separated by a small distance. Multifrequency antennas can have both arrays interleaved or overlapping within the same aperture. Multifrequency reflector and lens antennas combine multifrequency radiators with wideband lenses and reflectors of frequency-selective surfaces, others combine multifrequency or wideband radiators with separation filters. Some proposed antennas will operate as conventional ones at the higher frequencies and form an impedance structure excited by radiators around the aperture periphery at the lower frequencies. No complete theory of compound antennas is yet available, but some estimates can be made as to the effect of compounding on the performance characteristics: directive gain, power, transmission coefficient and side lobes. These estimates, based on theoretical relations and experimental data, indicate the need to reduce interference and to design a scanning system with phase as well as amplitude control for all frequency bands. Figures 8; references 45 1 Russian, 44 Western (5 in translation). [236-2415]

UDC 621.396.677.494

EXCITATION OF A FINITE ANTENNA ARRAY CONSISTING OF PLANE-PARALLEL WAVEGUIDES UNDER A DIELECTRIC LAYER

Kiev IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOELEKTRONIKA in Russian Vol 24, No 2, Feb 81 pp 48-54 manuscript received 17 Dec 79

KHIZMALYAN, A. D.

[Abstract] An antenna array consisting of plane-parallel waveguides under a dielectric layer and scanning in the E-plane is excited by E-type waveguide waves. The system of integrodifferential equations for the currents in the waveguide apertures is constructed according to the method of partial regions and then reduced, according to the Galerkin method, to a system of Kirchhoff equations. This system is of a high order and solving it requires the calculation of mutual admittances of harmonics. Here an efficient algorithm is proposed which includes a Poisson transformation, a discrete inverse Fourier transformation, and a fast Fourier transformation. Typical radiation patterns are calculated. The results indicate how the dynamics of dip formation in the directional diagram depends on the number of radiators in the array. Figures 5; references 9: 5 Russian, 4 Western (two in translation). [236-2415]

CERTAIN ASPECTS OF COMPUTER HARD AND SOFT
WARE: CONTROL, AUTOMATION, TELEMECHANICS,
TELEMETERING, MACHINE DESIGNING AND PLANNING

UDC 621.382

POSSIBLE MECHANISM OF DEGRADATION PHENOMENA IN MNOS STRUCTURES

Moscow MIKROELEKTRONIKA in Russian Vol 10, No 2, Mar-Apr 81 pp 127-131
manuscript received 8 Feb 80

AGAFONOV, A. I., PLOTNIKOV, A. F. and SELEZNEV, V. N., Institute of Physics,
USSR Academy of Sciences

[Abstract] A possible mechanism of degradation phenomena in MNOS memory devices is proposed on the basis of a simplified band structure, with two monoenergetic traps within the forbidden band of Si_3N_4 capturing electrons and holes, respectively. The equations for the rates of change of electron and hole concentrations in the respective traps are formulated and solved, disregarding diffusion and assuming a very slow recombination within the Si_3N_4 layer. With bipolar voltage pulses applied to the metal electrode, the changes in the device characteristics after an increasing number of switching cycles are established as being caused by a shifting of the trap saturation layer from the SiO_2 - Si_3N_4 boundary toward the SiO_2 -metal boundary. Figures 3; references 4: 2 Russian, 2 Western.
[238-2415]

UDC 621.382:681.14.32

STUDY AND ANALYSIS OF THE DIAGNOSTIC PROPERTIES AND CHARACTERISTICS OF MICRO-ELECTRONIC COMPUTER STRUCTURES DURING THE DESIGN STAGE

Moscow MIKROELEKTRONIKA in Russian Vol 10, No 2, Mar-Apr 81 pp 153-164
manuscript received 18 Jan 80

KUREYCHIK, V. M. and RODZIN, S. I., Taganrog Institute of Radio Engineering

[Abstract] A method of laying out microelectronic computer structures is proposed which meets the requirements for inspection and diagnosis during the process of their automated design. It ensures a balanced loading of chips, an optimum selection of check points and the prescribed depth of diagnosis. The structure is first simulated, as in the typical case of a switching circuit, with an organization

graph and then partitioned into chips so as to ensure approximately equal total costs of all elementary checks in each chip. The algorithms of the partition and the subsequent selection of check points can be easily tied to other algorithms of the design process: optimization of the number of interconnections or of external outputs, optimization of the total area and others. As revealed by an analysis of input-output routes, the thoroughness of diagnosis will depend on the interconnections between chips. This method is applicable to the design of microelectronic computer structures with complementary metal oxidesemiconductor (CMOS) large-scale integration. Figures 4; tables 3; references 5: 2 Russian, 3 Western (two in translation).
[238-2415]

CERTAIN ASPECTS OF PHOTOGRAPHY,
MOTION PICTURES AND TELEVISION

UDC 621.373.131:621.397.61

MODEL VTV-75 EXCITER (WITH SHIFT) FOR PRECISE SHIFTING OF CARRIER FREQUENCIES
IN METER-BAND TELEVISION TRANSMITTERS

Moscow ELEKTROSVYAZ' in Russian No 2, Feb 81 pp 10-14 manuscript received 3 Mar 80

TARAVKOV, A. N.

[Abstract] A television exciter has been built which ensures precise shifting of carrier frequencies by zero or up to ± 10.45 kHz with a diurnal relative instability within $\pm 5 \cdot 10^{-9}$. The exciter includes an operating unit and a standby unit, the latter providing a 100% reserve capacity. Each unit consists of three panels: one with a synchronizer of the reference-oscillator frequency, one with an excitation-frequency generator for the image transmitter and an excitation-frequency generator for the sound track, and one with a shift frequency generator. Each component is built entirely with transistors and microcircuit integration, assembled on PC boards, and energized separately. All are mounted together on a common rack. This VTV-75 exciter (with shift) has been found to operate satisfactorily in powerful radio-television transmitter stations and is intended for use with meter-band transmitters ("Uragan", "Len", "Igla", "Yakor'", "Zona"). Series production is being prepared at the Pilot Plant of the USSR Ministry of Communication. Figures 7; tables 1; references: 2 Russian.
[258-2415]

UDC 621.382

BULK DEVICE WITH CHARGE COUPLING FOR COLOR PHOTODETECTION

Moscow MIKROELEKTRONIKA in Russian Vol 10, No 2, Mar-Apr 81 pp 180-184
manuscript received 19 Feb 80

DENISENKO, V. V., KURBATOV, L. N. and SHAKHIDZANOV, S. S.

[Abstract] Bulk devices with charge coupling are used in color television photodetectors. Here the performance parameters of such photodetectors, namely the color resolution and the illuminance index, are compared with those of an ideal one with nonoverlapping spectral characteristics and equal quantum efficiencies

in all channels. The elements of the photosensitivity matrix, determined by the spectral dependence of the quantum efficiency, are calculated using the concepts of generation function and entrapment function. The latter is found from the solution to the diffusion-drift equation of motion for charge carriers in an electric field. On this basis, a 3-color silicon photodetector with charge coupling is optimized with respect to channel dimensions which will yield the maximum color resolution and correspondingly the maximum illuminance index. A material other than silicon with a larger dispersion of the absorption coefficient, such as a variband semi-conductor, will produce a color photodetector for a video signal shaper with even better performance parameters. Figures 4; references 16: 6 Russian, 10 Western (two in translation).
[238-2415]

UDC 621.397.13

SOME PROBLEMS IN MODERNIZATION OF TELEVISION TRANSMITTERS

Moscow ELEKTROSVYAZ' in Russian No 2, Feb 81 pp 15-19 manuscript received 26 Aug 80

FRIDMAN, E. M., ZININ, Ye. M. and ORLOV, V. V.

[Abstract] Modernization of television transmitters is primarily aimed at the low-power stages of large transmitters and low-power relay stations. Series production of completely satisfactory equipment for correction and stabilization of television signals is not anticipated in the near future, but a universal device for precorrection of video signals has been developed at the Smolensk Regional Radio-Television Transmitting Center and is recommended for use in existing transmitter stations "Igla", "Yakor'", and "Zona-1" among others. These stations require improvements in various areas. The main problems are stability of the h-f signal in the r-f channel of "Igla" stations, reliability and quality of image processing in "Yakor'" stations, conversion from tubes to transistors for higher efficiency, improving other technical indicators in "Yakor'" and "Zona-1" stations, and extending the capability of low-power TRSA satellite communication relays. Figures 8; references: 8 Russian.
[258-2415]

UDC 654.197.2

CONSIDERATIONS IN THE DESIGN OF CABLE NETWORKS FOR DISTRIBUTION OF TELEVISION SIGNALS

Moscow ELEKTROSVYAZ' in Russian No 2, Feb 81 pp 19-21 manuscript received 10 Jun 80

KODANEVA, T. A. and REUSHKIN, N. A.

[Abstract] An important consideration in the design of a cable line for distribution of television signals (programs) is the optimum parameters of the equipment which will ensure the maximum length of such a line. Here the performance

of such a line including n amplifiers in series which feed a receiver at the terminal is calculated in terms of the power and gain relations. An operating feature of such a line is a definite signal-to-noise ratio at the input to it for any signal level at the receiver output. The results of calculations indicate that the source noise will not influence the design parameters of the cable line, allowing a 4-6 dB decrease of the signal-to-noise ratio, while in a real cable line the signal-to-noise ratio will not decrease by more than 1-2 dB. The range of a cable line will not change significantly as the amplifier gain varies within a few decibels about its optimum level. This makes it feasible to use amplifiers with a nominal 25 dB gain in cable television networks. Figures 4; references 3: 2 Russian, 1 Western.
[258-2415]

TEST SEGMENT OF A TELEVISION TRANSMISSION NETWORK WITH REMOTE CONTROL AND INSPECTION

Moscow VESTNIK SVYAZI in Russian No 2, Feb 81 pp 29-30

PANKIN, S. V., chief of laboratory, Republic Center of Radio Broadcasting, Radio Communication and Television, Latvian SSR Ministry of Communication

[Abstract] A test segment of a television transmission network with remote control and inspection from a central point in Riga has been built as the pilot of a system for republic-wide centralized automatic control and inspection of broadcasting channels to ensure maintenance of a high-performance quality. The first stage is completed with maximum utilization of existing equipment such as controls and signaling from the "Il'men" radio station, a 100 km long line with video and audio channels as well as radio relay links, telephone trunks, and telegraph channels. The equipment also includes signal-level measuring instruments, control signal transmitters, receivers, and processor, data display and storage, teletypes and teleprinters. The control room has already been in operation, the need for a computer for data processing in real time has been established, and the experience can be well utilized in further expansion of the system over larger territories. Figures 1; tables 1.
[259-2415]

CERTAIN ASPECTS OF RADIOASTRONOMY,
SATELLITES AND SPACE VEHICLES

UDC 621.396.946

SIMULTANEOUS OPERATION OF INTERSATELLITE AND RADIO NAVIGATION SERVICES IN THE
32-33 GHz FREQUENCY BAND

Moscow ELEKTROSVYAZ' in Russian No 2, Feb 81 pp 32-36 manuscript received 11 Jun 80

KURAKOV, P. S.

[Abstract] According to CCIR regulations, the 32-33 GHz frequency band has been assigned to both intersatellite and radio navigation services. Their simultaneous operation is analyzed here with regard to interference. The effect of intersatellite communication along a geostationary orbit on radio navigation signals is calculated in terms of noise power relative to permissible interference power. The effect of radio navigation signals on intersatellite communication along a geostationary orbit is calculated in terms of power and gain attenuation. The results indicate that simultaneous operation of both services is possible only with some limits on radio navigation (the effective isotropically radiated power not to exceed 50 dB·W) and on intersatellite communication (the energy of the carrier signal to have a dispersion of at least 10 dB and the density of interference power from the intersatellite communication line on the surface of the earth not to exceed $163 \text{ dB} \cdot \text{W}/\text{m}^2 \cdot \text{MHz}$). The intersatellite communication systems are assumed to be uniformly distributed over the arc of a geostationary orbit so that not more than 15 interference signals can be picked up by the receiver on an aircraft. Figures 9; references 7: 3 Russian, 4 Western.
[238-2415]

UDC 621.396.946.2:621.396.6

DISCRETE PHASE-TYPE AUTOMATIC FREQUENCY TUNING OF MULTISTATION-ACCESS,
TIME-DIVISION EQUIPMENT WITH TIME DELAY

Moscow ELEKTROSVYAZ' in Russian No 2, Feb 81 pp 28-32 manuscript received 2 Jul 79

SIMONOV, M. M., PAN'KOV, G. Kh. and TSIRLIN, V. M.

[Abstract] Multistation-access, time-division equipment for satellite communication systems is considered with discrete phase-type automatic frequency tuning. For analysis purposes this regulator is regarded as consisting of an ideal pulsing

element such as a switch in series with a continuous part. The latter includes a zero-order extrapolator, a proportional low-pass filter and a time delay element. Its performance is evaluated by the method of transfer functions and with the aid of the Z-transformation, the time delay interval being replaced with a whole number m of readings. On this basis are calculated the transients in the synchronization circuit, the dependence of the steady-state tracking accuracy on the discretization period, and the linear range of the phase discriminator in the regulator loop. The results indicate that lengthening the discretization period increases the overregulation as well as the proneness to oscillations, thus also lengthening the transient period. Figures 3; references 4: 2 Russian, 2 Western (one in translation).

[258-2415]

UDC 629.195.2:621.39

CHOICE OF THE DESIGN VARIANT FOR SATELLITE BROADCASTING AND COMMUNICATION SYSTEMS

Moscow ELEKTROSVYAZ' in Russian No 2, Feb 81 pp 24-27 manuscript received 19 Aug 80

KANTOR, L. Ya. and PAUK, A. G.

[Abstract] Two variants of satellite communication systems are considered, one with a broadcast module and a telephone module in separate satellites and one with both modules in a common satellite. In each case there are n_1 ground stations for broadcast service only and $n_2 \ll n_1$ ground stations for telephone service only. A reliability and cost analysis, taking into account the useful life of a satellite, reveals that for a given reliability of the system there is an optimum ratio of satellite-to-ground station reliability which corresponds to the minimum total cost. A significant reduction of the overall cost of a highly reliable system is attainable only with long-life satellites. Increasing the antenna diameter in a ground station lowers the required transmitter power and allows for a higher receiver noise temperature there, with a resulting substantial cost reduction. The choice between the two variants depends on technoeconomic factors such as the number of ground stations. Generally a single satellite is preferable for up to 5000 ground stations and one module used in the distribution network. Two separate satellites are preferable for more than 5000 ground stations with two or more modules used in the distribution network. The latter variant is found in the "Ekran" system and in 12 GHz band systems such as the BSE. Figures 6; references: 3 Russian.

[258-2415]

DEVICES FOR OPERATING A RECEIVER STATION IN THE 'EKRAN' SYSTEM

Moscow VESTNIK SVYAZI in Russian No 2, Feb 81 p 31

IVANOV, O. A., senior engineer, "Orbita" Station

[Abstract] The satellite television broadcasting system primarily serves Western and Eastern Siberia. The performance of the communication channels there is monitored at several control receiver stations with feedback channels to the transmitting center. A class-1 device of the "Ekran" system with a special PP antenna for high-quality reception of satellite signals serves as a control receiver. Such a receiver operates in conjunction with a line (horizontal) signal tester, a telemetry transmitter, a ground communication channel, and the satellite communication transmitter. The performance of such a feedback channel is checked with a recording instrument. The functions of a control receiver include daily measurement of the intensity of the electromagnetic field produced by the transmitter on board the satellite, measurement of the signal-to-noise ratio before and after each broadcast, and standard as well as special testing in the "Ekran" system. The performance of a control receiver is checked by a transmitter simulating the one on board the satellite. This simulating control transmitter has a mixer stage where the 644 MHz frequency from a master oscillator is added to the 70 MHz frequency from a frequency modulator modulating the signal from a television signal generator. As one of the improvements made on this control transmitter, a low-noise high-frequency amplifier with less temperature-sensitive KT392A transistors is being developed so that a set of p-i-n switching diodes can also be installed at the input of the control receiver for connecting the latter either to the antenna or to the control transmitter. Figures 2.

[259-2415]

COMMUNICATIONS, COMMUNICATION EQUIPMENT, RECEIVERS
AND TRANSMITTERS, NETWORKS, RADIO PHYSICS, DATA
TRANSMISSION AND PROCESSING, INFORMATION THEORY

UDC 621.391

METHOD OF EVALUATING THE INTERFERENCE IMMUNITY OF CORRELATIONAL DETECTION OF
CONTINUOUS RANDOM SIGNALS

Moscow RADIOTEKHNIKA in Russian No 2, Feb 81 pp 58-62 manuscript received 30 Jan 80

DENISENKO, A. N.

[Abstract] The dependence of the detection probability on the false-alarm probability describes the interference immunity of a detection system most accurately, but no expressions have as yet been derived for these probabilities during continuous processing in the limiting case of sample enlargement within a given time interval. Here expressions are derived which are specifically applicable to correlational processing of random signals. An additive mixture of signal and interference is assumed to appear at the detector input, with a normal distribution of signal fluctuations. The interference immunity of a detector with an RC filter is evaluated on this basis and the dependence of the detection probability on the false-alarm probability in this case is found to be determined by the signal-to-noise ratio at the input, the length of the observation time, the time constant of the filter and the form of the correlation function, i. e., the width of the signal+interference energy spectrum. Figures 1; references 4: 2 Russian, 2 Western (one in translation). [240-2415]

UDC 621.391

NEW METHOD OF SEPARATING TWO FM SIGNALS TRANSMITTED IN THE SAME FREQUENCY BAND

Moscow RADIOTEKHNIKA in Russian No 2, Feb 81 pp 62-65
manuscript received after completion 21 Mar 80

BYKHOVSKIY, M. A.

[Abstract] A new method of transmitting information through FM signals is the formation of two such signals of equal amplitudes and 90° apart in phase, with oscillations of their carrier frequencies precisely synchronized. The receiver

includes two synchronous phase detectors and a phase-type automatic frequency control. Here such a receiver with filterless synchronous phase detectors and a negligibly low rate of phase change is analyzed. Its efficiency of separating the two signals is evaluated in terms of noise power. The latter is found to be 1.7-2 dB higher than in a receiver where each signal is demodulated by a frequency detector in a separate channel. A high-pass filter added to each synchronous phase detector will improve the signal separation. This method is applicable not only to radio and satellite communication but also to television and even sound recording, as well as to two-way mobile communication systems. Figures 1; tables 1; references: 6 Russian.
[240-2415]

UDC 621.391

MATRIX METHOD OF DIGITAL CORRECTION IN THE FREQUENCY DOMAIN

Moscow RADIOTEKHNIKA in Russian No 2, Feb 81 pp 15-18
manuscript received after completion 20 May 80

KOROBKOV, D. L.

[Abstract] A method of suppressing intersymbol interference (II) in message reading is described which, unlike harmonic correction makes it possible completely to suppress II, and is realizable in effective digital form. Messages entering the channel are uncorrelated and separated by zeros so that they can be processed independently, their distribution being arbitrary with a zero mathematical expectation and a nonzero dispersion. Uncorrelated but normally distributed Gaussian noise is also present, and the channel response has a finite duration in the time domain. The method involves manipulation of the matrices in the receiver signal vector, discrete Fourier transformation of its components into the frequency domain, and optimization for minimum mean-squared error of its subsequent linear transformation. As a result a matrix correction factor for the receiver signal is obtained which represents the optimum receiver of signals in the presence of both intersymbol interference and Gaussian noise. The number of multiplications necessary for one reading of the output signal is $4 \cdot \log_2 \frac{M}{T}$ (M --dimensionality of the message vector). References 6: 4 Russian, 2 Western.
[240-2415]

ELECTRICALLY CONTROLLABLE PHASE SHIFTERS BASED ON A CHAIN CONNECTION OF FOUR-POLES

Moscow RADIOTEKHNIKA in Russian No 2, Feb 81 pp 43-46
manuscript received after completion 2 Jul 80

GAMAN, T. V. and ZAPOROZHETS, V. V.

[Abstract] A chain of four-poles can be used for controlling the signal phase and delay time in lines with lumped or distributed parameters. Analyzed here is the performance of phase shifters designed for minimum losses within the range of maximum phase shift. The figure of merit, namely the ratio of phase shift to maximum losses, peaks within the optimum tuning range, and the latter corresponds to changing the line frequency from 0.2 to 0.8 of the cutoff frequency. Coils with a magnetic core and a permeability-dependent inductance and p-n junction varicaps with a voltage-dependent capacitance can serve as the controllable elements of such a chain. The feasibility was tested over the 2-30 MHz frequency range with discrete inductance and capacitance tuning from 1.0 to 5.0 μH and from 50 to 250 pF respectively, by mechanical switching in a 10-section chain. Figures 3; references: 6 Russian.
[240-2415]

SPECTRA OF COMPLEX SIGNALS WITH POST-DETECTOR PROCESSING

Kiev IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOELEKTRONIKA in Russian Vol 24, No 1, Jan 81 pp 85-86 manuscript received 29 Jun 79, after revision 13 Mar 80

SUSLONOV, S. A. and KNYSHEV, I. P.

[Abstract] The nature of the changes which arise with post-detector processing is studied and the conditions placed on the spectrum of a signal in order to eliminate these changes are determined. By studying a linearly frequency-modulated signal, equations are derived which describe the changes in properties of the signal. The equations can be used to simplify the formation of signals or to expand the capabilities of a typical system. Two conditions are defined under which the properties of the system are retained: the amplitude spectrum must be even-symmetrical, the phase spectrum--odd-symmetrical; the envelope of the signal must be an analytic signal, the real and imaginary parts of which are related by a Hilbert transform. Figures 2; references 5: 4 Russian, 1 Western.
[230-6508]

ADAPTIVE DETECTION OF A TRAIN OF RADIO PULSES SUBMERGED IN PASSIVE INTERFERENCE

Moscow RADIOTEKHNIKA in Russian No 2, Feb 81 pp 68-70 manuscript received 10 Jan 80

LIKHAREV, V. A. and KRAVCHENKO, V. N.

[Abstract] Adaptive detection of deterministic signals, required when the covariational matrix of the passive background interference is not known a priori, is considered here for pulse trains with an interference power much higher than the power of the useful signal. The classifying statistic is then a linear discriminant function, obtained by replacement of the covariational matrix with its maximum likelihood estimate. The detection algorithm is simplified by factorization of the inverse covariational matrix. Formation of the classifying statistic now involves "whitening" of the correlated interference by means of adaptive "whitening" filters with weighting coefficients determined by the spectrally correlated characteristics of the passive interference and by the connectedness of the approximating Markov sequences. The distribution of the linear discriminant function is needed for an analysis of the thus synthesized adaptive detectors. Here only an approximation of this very intricate distribution is used, namely its principal term, sufficiently accurate for N (number of samples) $> n$ (dimensionality of the signal vector) > 20 . The number of required samples N decreases for a signal vector with fewer dimensions n , but reduction of the loss in the threshold signal-to-noise ratio below 3 dB requires $N > 25$. Figures 1; references 5: 4 Russian, 1 Western (in translation).
[240-2415]

NOISE IMMUNITY OF SPEECH MESSAGES IN WIDEBAND RADIO TELEPHONE COMMUNICATION SYSTEMS

Kiev IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOELEKTRONIKA in Russian Vol 24, No 1, Jan 81 pp 56-61 manuscript received 23 Jul 79, after revision 23 Jun 80

LOSIAKOV, S. N. and NEKRASOV, I. S.

[Abstract] Studied here is the intelligibility of speech messages at the output of a radio channel carrying analog wideband signals with supplementary FM, in which the frequency changes both under the influence of the information oscillation and under the influence of a secondary oscillation which determines the rule and limits of change of the carrier. The transmission band is narrow in comparison to the band of frequencies within which the carrier frequency varies due to secondary frequency modulation. Therefore narrow band interfering radiation which is present causes pulsed interference, and the intelligibility of speech depends on the structure of the concentrated interference. The noise immunity of speech messages without special devices to control concentrated interference is calculated. When special devices are used, intelligibility can be improved if

the frequency of the secondary FM modulating signal is over 65 Hz. The blanking method allows acceptable intelligibility to be achieved even with interference up to 70% of the total transmitted spectrum. Figures 3; references: 10 Russian. [230-6508]

CENTRALIZED SERVICING OF IKM-30 PULSE-CODE-MODULATION EQUIPMENT IN AN URBAN TELEPHONE NETWORK

Moscow VESTNIK SVYAZI in Russian No 2, Feb 81 pp 22-23

YAUTRUMS, A. A., chief of production laboratory, Riga Urban Telephone System

[Abstract] NS-30/32 pulse-code-modulation (PCM) equipment manufactured by the "Nokia" (Finland) Firm has recently been installed for digital transmission in the Riga Urban Telephone System. Servicing this equipment includes repairs as well as preventive periodic testing. The latter involves monthly inspections (reliability), semiannual inspections (master-frequency stability, overall gain, signalization, regenerator stability margin), and annual inspections (amplitude-frequency characteristics, quantization signal-to-noise ratio, noise in free channels, crosstalk immunity, service communication, conditions of containers and cables, voltage and current from remote power supplies). All these services are being centralized so that 3-4 persons can take care of up to 50 PCM systems. During the first year it was necessary to replace primarily signalization modules, amplifier modules (because of excessive crosstalk) and two-way regenerators (because of excessively high error probability). The main problems are availability of spare parts and transportation facilities for emergencies, especially during evening and night hours. No official instructions for servicing are given, all schedules and operations are being improvised and continually improved in order to ensure better efficiency and shorter shutdown periods. Typical in this respect is fault detection, for which the procedure has been streamlined, as well as repair of encoders, registers, and voltage stabilizers. While repairs are still being made at the Production Laboratory, of the Riga Urban Telephone System, problems of centralization are also worked on there. Figures 1. [259-2415]

EFFORTS TO IMPROVE THE RELIABILITY OF OPERATING COMMUNICATION EQUIPMENT

Moscow VESTNIK SVYAZI in Russian No 2, Feb 81 pp 25-27

BIKKARD, V. A., department chief, and KLUBAKOV, V. Ya., project engineer, Sverdlovsk branch of the Central Design Office, USSR Ministry of Communications

[Abstract] While modern communication equipment is being developed, efforts are also underway to improve the performance of existing equipment. One project involves replacement of the unreliable RPN and RP4 electromagnetic relays in general-purpose UVP-2 telegraph ringing sets and in semiautomatic interurban telephone networks. The new PRP-UVP semiconductor transceiver consists of a transmitter and a receiver, both modules built on printed-circuit boards. It is a 2-pole asymmetric 4-wire device converting bipolar signals to unipolar ones, for operation at +60 V with a grounded center tap and a 16-27 V output voltage across a 1000+100 ohm load. Another project is replacement of the switching relays in the output circuits of the tone-frequency dial signal generator in IKTN-M and VKTN-M 2-frequency semi-automatic sets. The new CRCh static relay consists of four transistor switches with a possibility of polarity change by connection reversal. Its amplitude-frequency characteristic is linear within 0.1 dB, with a signal distortion not exceeding 2% across a 600 ohm load at $F_1 = 1200$ and $F_2 = 1600$ Hz (also $F_3 = 1200+1600$ Hz). It is energized from a -60 V dc supply. Both devices are ready for series production at enterprises of GUPP (Main Administration of Industrial Enterprises). Figures 2.

[259-2415]

UDC 621.394-654.16

CALCULATION OF THE CHARACTERISTICS OF THE SERVICING AND REPAIR SYSTEM FOR TELEGRAPH EQUIPMENT IN TERMINAL STATIONS

Moscow ELEKTROSVYAZ' in Russian No 2, Feb 81 pp 60-62
manuscript received 7 Jul 77

D'YAKONOV, A. S.

[Abstract] The reliability indicators of telegraph equipment in terminal stations dispersed over a territory depend largely on the performance of the servicing and repair system. Most popular is such a system organized in sections, where a technician is assigned to a certain number of stations and moves from one to another as calls for servicing or repair come in. For the purpose of analysis, such a system is treated as a one-line priority-type queuing system with an unlimited waiting time and without interruptions in servicing. With the personnel travel time taken into account, the performance of such a system is analyzed here in terms of efficiency with the following criteria: equipment shutdown factor, mean waiting time for servicing, mean servicing time where repair is needed, mathematical expectation of the number of repair calls in a queue, and the personnel employment factor. Appropriate formulas are derived by the method of a supplementary event, with the aid of the Laplace-Stieltjes transformation,

and the system characteristics are calculated for the typical case of a technician assigned to 6 terminal stations with a total of 30 telegraph sets. Tables 1; references 5. 3 Russian, 2 Western (both in translation).
[258-2415]

UDC 621.394.4

NEW STAGE ALONG THE PATH OF IMPROVING CHANNEL EQUIPMENT

Moscow ELEKTROSVYAZ' in Russian No 2, Feb 81 pp 45-49
manuscript received 7 Aug 80

MARTSENITSEN, S. I., KOROL', V. I., KOROP, B. V., BUKHDRUKER, I. M., USOV, I. S. and STEPANETS, V. A.

[Abstract] A new multiplexer with time division is described which, when built according to ITTCC recommendations, can operate directly in digital channels (synchronous, code-dependent, code-independent) with a transmission capacity of 2.4 kbit/s. With a line cell it can also operate in pulse-code-modulation channels. With a 2.4 kbit/s modem it can operate in tone-frequency and urban cable telegraph channels. The use of this multiplexer requires heavy-duty bundles of discrete channels in the main arteries as well as in zonal and local segments of the network. Experience already gained in the operation of DATA and DUMKA equipment is applicable here, especially with regard to the organization and layout of channels. Figures 2; tables 1; references 5: 3 Russian, 2 Western (both in translation).
[258-2415]

UDC 621.394.423:621.396.62

OPEN DIGITAL CLOCK SYNCHRONIZATION SYSTEMS IN RECEIVERS

Moscow RADIOTEKHNIKA in Russian No 2, Feb 81 pp 65-68
manuscript received after completion 20 Jun 80

POBEREZHSKIY, Ye. S. and SOKOLOVSKIY, M. N.

[Abstract] In closed clock synchronization systems operating with automatic tuning, the synchronization time depends on the initial mismatch between synchronization signals and received pulse trains, which is particularly undesirable during short communication periods over channels with fadeout. This drawback is eliminated in an open digital clock synchronization system consisting of a phase meter, a phase-to-code converter, a storage, a reference-frequency module, a frequency divider, a pulse shaper and a processor. Phasing is effected by dropping the frequency divider to the zero level. The storage can operate with either total erasure between cycles or successive individual erasures within each cycle. Here the digital characteristic of such system which implements the

"m out of n" algorithm according to the Neyman-Pearson criterion for $m > 0.5n$ is calculated, namely the dependence of the mean synchronization time on the probability of attaining synchronism and on the mean time of synchronism during intermission periods. In this system, just as in a closed one, shortening of the synchronization time by decreasing m will result in a shorter time of synchronism during intermission periods. This drawback can be eliminated by introduction of two thresholds: a relatively low m_1 for fast synchronization under light loads and a sufficiently high m_2 for exclusion of spurious synchronization under heavy loads. Such a scheme is shown in a system with successive erasure which includes a ring commutator and two storing frequency dividers behind the phase meter, an analyzer of the number of synphasal dividers, an OR gate before the main frequency divider and a pulse train counter. Figures 3; references: 3 Russian.
[240-2415]

UDC 621.395

EFFECTIVENESS OF TWO-WAY TRUNKS IN COMMUNICATION NETWORKS

Moscow ELEKTROSVYAZ' in Russian No 2, Feb 81 pp 37-42 manuscript received 28 May 80

KORNYSHEV, Yu. N.

[Abstract] Replacement of one-way trunks with two-way trunks in telephone networks reduces the loss of messages because the effectiveness of two-way trunks depends on the bundle structure and capacity as well as on the load characteristics and the losses caused by counterconnections. Here the performance of such a trunk is analyzed, with a counterconnection treated as two independent events to which the multiplicative law of probability applies. The transmission capacity of a network can be increased by reducing the probability of counter connections. Moreover, the loss of messages can be reduced by mixing two-way and one-way bundles in the trunk. These are important factors in the design of the switching system and they affect the overall economy of the network. In the Soviet Union two-way trunks have so far been installed only in small rural automatic telephone networks with exchanges such as the K-40/80 and K-50/200, but they are also being considered for use in larger rural and urban automatic telephone networks with K-100/2000 exchanges. The author thanks A. M. Zelinskiy and V. G. Kononovich for assistance in computer calculations, as well as V. K. Bazyk for the collaboration in technoeconomic analyses and A. Ya. Markovich for constructive discussion of the results. Figures 4; tables 2; references: 8 Russian.
[258-2415]

CALCULATING THE RELIABILITY OF A COMMUNICATION NETWORK WITH A MULTITUDE OF PATHS

Moscow ELEKTROSVYAZ' in Russian No 2, Feb 81 pp 42-44
manuscript received 27 Jun 79

BOGATYREV, V. A.

[Abstract] A pair of junctions in a branching network is considered between which communication can be effected over any of many available paths. With the reliability known of all network elements including the communication channels, the problem is to determine the reliability of communication between these two junctions. The problem is mathematically reduced to one of parallel paths, taking into account that some paths may cross at common points and thus not be independent. The problem is solved according to the rules of probability calculus and by simplifying as much as possible the multiplication of binomials. As a result, a general expression is obtained with by far fewer terms than the maximum number 2^n for n paths. Figures 2; tables 1; references: 1 Russian.
[258-2415]

COMPARABILITY OF RADIOELECTRONIC SYSTEMS ACCORDING TO THE THEORY OF SETS

Moscow RADIOTEKHNIKA in Russian No 2, Feb 81 pp 19-21
manuscript received 15 Feb 80

YURLOV, P. P.

[Abstract] The comparability of radioelectronic systems is considered from the standpoint of the mathematical theory of tolerance. The gist of this approach is the selection of engineering solutions from alternatives by analysis of a set of X variants whose elements are characterized by a set of efficiency indicators and a set of loss indicators, both subject to given requirements. Such a comparability is both reflexive and symmetric, and tolerance comparability can be defined with respect to either. Various corresponding reflections through which a comparability of alternatives is realized are also defined and described. This method of comparative evaluation is demonstrated on examples of alternative modulation systems, where either the maximum efficiency or the minimum loss is sought. References: 4 Russian.
[240-2415]

METHOD OF MULTIPLEXING OPTICAL CHANNELS

Moscow RADIOTEKHNIKA in Russian No 2, Feb 81 pp 82-84

manuscript received 14 Feb 80

BORISOV, E. V.

[Abstract] Pulse-position-modulation is an effective method of modulating optical radiation in discrete channels. Another method is pulse-code-modulation with polarization, where "1" and "0" correspond to radiation with circular polarization in respectively opposite directions. Here multiplexing an optical channel by combining both methods of modulation is considered. The algorithm of receiver operation with two photodetectors, one for each circular polarization, is based on four readings and their linear combinations. An evaluation of the interference immunity of these two channels, assuming a Gaussian distribution of the number of photoelectrons during one reading, reveals that the mean probability of error is somewhat higher here than in a simplex channel with pulse-position-modulation only. An advantage of multiplexing is the rate of data transmission which is two times as high. Figures 2; references 3: 2 Russian, 1 Western.
[240-2415]

UDC 621.397.12:621.376.57

EXPERIMENTAL COLOR FACSIMILE DEVICE WITH DIFFERENTIAL PULSE-CODE-MODULATION

Moscow ELEKTROSVYAZ' in Russian No 2, Feb 81 pp 49-52

manuscript received 1 Jul 80

GAVRILOV, L. V., KOVALENKO, A. M., KULIKOVSKIY, O. V., RYZHKOV, M. V. and UZILENSKIY, V. A.

[Abstract] An experimental color facsimile system consisting of a transmitter and a receiver with three channels in each is described. The system was developed in the Problems Laboratory at the Leningrad Electrotechnical Institute of Communications imeni M. A. Bonch-Bruvevich. Its operation is based on differential pulse-code-modulation. The three stages of transmitter operation are an analysis of a color video signal from the original, their analog processing with three logarithmic devices, a color corrector and three low-pass filters for limiting the spectrum, and analog-to-digital conversion. The three stages of receiver operation are digital-to-analog conversion, analog processing with three low-pass filters for limiting the spectrum, three compensating gradation correctors and three recording amplifier, and synthesis for the copy. The performance of analog-to-digital and digital-to-analog converters has been evaluated for this application, particularly in terms of the minimum number of quantization levels in all three channels (blue, purple, yellow) on both sides and the optimum quantization scale for a high-quality transmission of color originals. The system was

tested in a real channel with a stroke frequency of 25.6 kHz in a geostationary satellite communication system with a 2048 kbit/s terminal loop. Figures 4; tables 3; references 6: 4 Russian, 2 Western.
[258-2415]

UDC 628.434.25.054.92

**CHARACTERISTICS OF OPTIMAL ESTIMATES OF THE PARAMETERS OF OPTICAL SIGNALS
AGAINST A BACKGROUND OF SPATIAL NOISE**

Kiev IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOELEKTRONIKA in Russian Vol 24,
No 1, Jan 81 pp 14-21 manuscript received 22 Oct 79

TRIFONOV, A. P., ZYUL'KOV, A. V. and MARSHAKOV, V. K.

[Abstract] A study is made of the characteristics of maximum probability estimates of the parameters of optical signals with anomalous errors taken into account. Such estimates are considered to be the optimal algorithm for evaluating the effectiveness of optical signal processing systems. Procedures for estimating the position and amplitude of optical signals are outlined. For signals with unknown position, the amplitude estimate is biased and its characteristics depend not only on the signal-to-noise ratio, but also on the adjusted volume which characterizes the number of signals which can be placed in a given area. The dispersion of the estimate may be increased by more than an order of magnitude when the position of the signal is unknown. Figures 1, references:

8 Russian.
[230-6508]

COMPONENTS AND CIRCUIT ELEMENTS,
WAVEGUIDES, CAVITY RESONATORS AND
FILTERS

UDC 621.372.826

DESIGN OF COUPLED RECTANGULAR ANISOTROPIC DIELECTRIC WAVEGUIDES

Kiev IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOELEKTRONIKA in Russian Vol 24,
No 2, Feb 81 pp 104-107 manuscript received 27 Nov 79, after revision 27 May 80

BEREZA, A. Ye. and KANUNNIKOV, V. P.

[Abstract] Rectangular anisotropic dielectric waveguides with distributed coupling have so far been studied only experimentally and on the basis of numerical analysis in the planar waveguide approximation. The latter method is inaccurate and, therefore the variational method is used here instead. The dielectric permittivity is appropriately treated as a tensor quantity and the solution to the Maxwell field equations is obtained in the form of eigenmodes corresponding to a uniaxial crystal in the waveguide, variously oriented relative to its principal optical axis. The longitudinal propagation constant is then calculated from the variation principle, assuming only transverse anisotropy. The subsequent calculation of the linear coupling coefficient has been programmed in ALGOL for an M-222 computer. This method is found to be useful for the design of such waveguides and optimization of their coupling. Figures 3; references: 2 Western.
[236-2415]

UDC 621.372.832

LOOP DIRECTIONAL COUPLERS WITH ELECTRICALLY CONTROLLED TRANSIENT ATTENUATION

Kiev IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOELEKTRONIKA in Russian Vol 24,
No 1, Jan 81 pp 8-14 manuscript received 26 Oct 79, after revision 7 Apr 80

USOV, N. Yu.

[Abstract] A study is made of electrically controlled loop directional couplers with equidistant placement of coupling elements. The transient attenuation of the coupling elements is controlled by p-i-n structures with longitudinal distribution. Studies were performed in the 2-centimeter band. In one of the designs the initial transient attenuation was achieved by four identical loops,

in the other by four loops, the wave impedances of which were distributed according to a binomial rule. The experiments showed that loop directional couplers with semiconductor structures having longitudinal distribution within the loops are extremely wideband devices. The controlled directional couplers with nonresonant coupling elements studied in this article can be used in high-power measurement installations, and also as functional microwave units in various types of systems. Figures 4, references: 6 Russian. [230-6508]

UDC 621.374.5

SURFACE WAVES IN SHIELDED MULTILAYER STRUCTURES WITH A FERRIMAGNETIC MATERIAL

Kiev IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOELEKTRONIKA in Russian Vol 24, No 1, Jan 81 pp 89-92 manuscript received 17 Oct 79, after revision 28 Mar 80

BEREGOV, A. S. and KUDINOV, Ye. V.

[Abstract] A study is made of the possibility of expanding the frequency band within which the delay time is constant for a dielectric-ferrite-dielectric structure grounded on both sides. The equations which describe the structure are obtained from the full equations of Maxwell, allowing the boundaries of applicability of the magnetostatic approximation to be determined and refining the dispersion characteristics of the magnetostatic waves in the area of small wave numbers. The structure studied consists of infinite plates plus conducting planes. Analysis of the frequency dependence of the group wave velocity propagating through the structure demonstrates the possibility of expanding the dispersion-free section of retunable delay lines by the implication of a second grounded plate separated from the ferrimagnetic structure by a dielectric layer. Figures 2, references 6: 1 Russian, 4 Western, 1 Japanese. [230-6508]

UDC 621.376.22:621.372.862.3.07

AMPLITUDE MODULATION OF OSCILLATIONS IN A LIGHT GUIDE

Kiev IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOELEKTRONIKA in Russian Vol 24, No 1, Jan 81 pp 102-104 manuscript received 30 Oct 79

YANOVSKIY, M. S. and KNYAZ'KOV, V. N.

[Abstract] Amplitude modulation of oscillations in a light guide can be performed by modulators based on polarization quasi-optical attenuators. Regulation of the modulation coefficient in such devices can be achieved by the use of symmetrical two-channel systems including an attenuator with rotating polarization in one channel and a level regulating attenuator in the same channel. It is more promising

to construct an amplitude modulator on the basis of a polarization attenuator with reflecting polarizers. A controlled light guide modulator without the shortcomings and limitations of previous devices is suggested. The device is based on a hollow dielectric light guide and is intended to operate at 0.5 to 2.2 mm wave length. A wire lattice made of parallel metal wires with a spacing much closer than the wave length is placed in the diagonal plane of symmetrical branching of a hollow dielectric light guide. Two-faced rectangular corner reflectors are placed in the two arms of the branch, covering the entire cross section. One can be rotated relative to the axis of the wave guide. A wire grid is placed in the output arm at an angle of 45° to the axis of the light guide. The operation of the modulator is explained. There is separate formation of the oscillations at the carrier frequency (upon reflection from the non-moving corner reflector) and the side band frequencies (upon reflection from the rotating corner reflection), after which these oscillations are added by the polarizing grid. Figures 1; references: 6 Russian.
[230-6508]

UDC 621.382

MOTION OF THE INTERPHASE BOUNDARY IN VO_2 FILMS DEPENDING ON THE CONDITIONS OF INITIATION OF A PHASE TRANSITION

Moscow MIKROELEKTRONIKA in Russian Vol 10, No 2, Mar-Apr 81 pp 184-188
manuscript received 11 Mar 80

PAKSEYEV, V. Ye., GOLIK, L. L. and YELINSON, V. M., Institute of Radio Engineering and Electronics, USSR Academy of Sciences

[Abstract] The motion of the metal-semiconductor phase transition front in VO_2 films behind a thermal wave which propagates during switching is considered for use as the basis of multistap delay lines. The operating speed and other performance parameters of any such device will depend on the velocity and the nature of that phase transition front as well as on the conditions of its initiation. This dependence was studied in an experiment with a VO_2 film between aluminum electrodes split into three isolated regions: a wide central one for measurements and two narrow ones at the edges for excitation. A phase transition front was initiated by application of a voltage pulse to one edge region through an appropriate resistor, a pulse of sufficient amplitude and duration to generate a thermal wave through the central region. Measurements were made in order to determine the dependence of the velocity of the interphase boundary (phase transition front) on its location and the dependence of its travel time on the temperature, for various combinations of the load circuit parameters corresponding to initial and final states of the film. The conditions of the experiment were maintained and varied in accordance with the current-voltage characteristic of this VO_2 device. The results indicate the feasibility of moving a phase transition front through three electrically isolated regions and using this effect for a multistap device with widely controllable parameters. Optimum switching of output signals and minimum power dissipation in such a device require a moving filament of the conducting (metal) phase rather than of the phase transition front.

This can be achieved by a special configuration of the electrodes. The authors thank L. A. Ryabov and I. A. Serbinov for providing the VO_2 films for part of this study. Figures 5; references 5: 3 Russian, 2 Western.
[238-2415]

UDC 621.391.84.037.372

USE OF THE PRINCIPLES OF DISTRIBUTED ARITHMETIC IN THE CREATION OF WAVE DIGITAL FILTERS

Kiev IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOELEKTRONIKA in Russian Vol 24, No 1, Jan 81 pp 98-101 manuscript received 19 Oct 79, after revision 25 Feb 80

GORSHKOV, A. K., LESNIKOV, V. A., PETROV, Ye. P. and CHASTIKOV, A. V.

[Abstract] The use of a finite number of binary digits in order to represent the coefficients in digital filters reduces accuracy. Two methods are known to improve accuracy: an increase in the number of digits, and the use of special structures with low sensitivity to manufacture the digital filters. Wave digital filters have the required low sensitivity, but the complexity of the structure of these devices makes them expensive and impractical. The present brief communication suggests a transformation to the equations describing wave digital filters which allow effective utilization of the principles of distributed arithmetic in their manufacture, significantly reduce hardware cost and increase the uniformity of structures. In contrast to the classical method of implementing wave digital filters, the effectiveness of which increases with a decrease in the number of multiplications necessary, the effectiveness of principles of distributed arithmetic increases with a decrease in the number of additions required. The use of the principles of distributed arithmetic for implementation of the equations which describe the wave digital filters can reduce the hardware cost by a factor of two or three in comparison with the classical implementation. The approach to the implementation of filters described in this work can also be used for the design of low- and high-frequency filters with approximation of the AFC by a Zolotarev fraction, as well as band-pass and band-stop filters. Figures 3, references 9: 2 Russian, 7 Western.
[230-6508]

UDC 621.391.84.037.372

COMBINATORIAL SYNTHESIS OF DIGITAL WAVE FILTERS

Moscow RADIOTEKHNIKA in Russian No 2, Feb 81 pp 41-43
manuscript received 21 Mar 80

GORSHKOV, A. K., LESNIKOV, V. A., PETROV, Ye. P. and CHASTIKOV, A. V.

[Abstract] Combinatorial or "distributed arithmetic" synthesis of digital filters is an efficient method of synthesis, because it does not include

multiplications in the computation process. Such a synthesis of digital wave filters proceeds in two stages. First one constructs a microwave filter containing lossless transmission line segments from an analog LC filter. Then one replaces the analog components with their digital equivalents described in terms of the Z-transformation and connected through special series adapter circuits. This procedure is demonstrated here on a low-pass filter of the third order with a monotonic amplitude-frequency characteristic in the stop band, a ladder configuration ensuring a low sensitivity of that characteristic to the accuracy of the coefficients. The system of equations describing an adapter circuit is, furthermore, transformed so as to minimize the number of additions and thus reduce the necessary number of adders. Such a filter is shown which consists of 19 shift registers, 6 storages and 6 adders. It is suitable for signal processing in real time. Figures 4; references 5: 1 Russian, 4 Western.
[240-2415]

UDC 621.396.22.019.4:621.396.13

DISTORTION OF THE CORRELATION FUNCTION FOR COMPLEX SIGNALS IN REJECTION FILTERS

Moscow RADIOTEKHNIKA in Russian No 2, Feb 81 pp 52-55
manuscript received 12 May 80

TUZOV, G. I., SIVOV, V. A. and BYKOV, V. V.

[Abstract] A rejection filter for complex signals which appear with a nonuniform interference spectrum is considered. The filter consists of n parallel channels for the corresponding n frequency bands into which the signal spectrum has been subdivided. The amplitude spectra of a signal with periodic phase manipulation and a signal with discrete frequency modulation, with the conventional indeterminacy function, are used for calculating the correlation function in each case as well as its distortion: the effect of band elimination on the amplitude and the width of its major lobe and the increase of side lobes. The distortion of the discriminator characteristic, namely the dependence of its slope on the width of an eliminated band, is also calculated for each case with either a coherent or a noncoherent discriminator. A coherent discriminator ensures a large slope of the almost linear characteristic. Figures 3; references: 2 Russian.
[240-2415]

UDC 535.854/417:531.715

INTERFERENCE CONVERTER AS A DEVICE FOR SHIFTING THE SPECTRUM OF A PHOTOELECTRIC SIGNAL

Leningrad IZVESTIYA VYSSHIYE UCHEBNIKH ZAVEDENIY: PRIBOROSTROYENIYE in Russian No 1, Jan 81 pp 80-84 manuscript received 14 Feb 80

ROZOV, B. S. and SHCHURENKOV, A. A., Moscow Engineering Physics Institute, recommended by the Department of Automatics and Telemechanics

[Abstract] Spectral conversion is employed in heterodyne interferometers to obtain information on the motion of an object. The information is contained in the instantaneous spectrum of the measurement signal, where perturbing factors must be taken into account. Conversion of a photoelectric signal spectrum is accompanied by the appearance of combination harmonics which are responsible for nonlinearity in the static characteristic of the converter as well as systematic measurement errors. This paper analyzes the sensitivity of these spectral components to the perturbations for various spectral conversion techniques. The analysis generates the following ranking of such techniques with respect to the reduction in the sensitivity to measurement error: the spectral conversion of a photoelectric signal by means of electrical heterodyning, which consists in the conversion of the quadrature interferometric signals and the carrier frequency, is the most vulnerable in terms of the sensitivity of the spectral components to the perturbing factors; interferometric modulation is next, followed by polarization separation of the light components of different optical frequencies, while spatial resolution based on traveling ultrasonic diffraction is the least sensitive to perturbations. The theoretical treatment adduces general mathematical expressions describing such converters, though no specific sample calculations or experimental data are given. References 9: 6 Russian; 3 Western (1 in translation).
[213-8225]

METHOD OF MATHEMATICAL SIMULATION OF COMPLEX RECTIFIER-CONVERTER SYSTEMS

Moscow ELEKTRICHESTVO in Russian No 2, Feb 81 pp 61-64 manuscript received 29 May 80

ANTONOV, B. M., candidate of technical sciences, PISHCHIKOV, S. I., candidate of technical sciences, and SLUCHANKO, Ye. I., engineer

[Abstract] A method is proposed for mathematically simulating nonlinear complex rectifier-converter systems on an analog computer. The method involves construction of equivalent circuits which consist of converters in a series-parallel connection. Its principle is first demonstrated by a simple system consisting of a d.c. source with an emf and an internal resistance, a rectifier and the industrial a.c. network. It is then extended to a more general real system consisting of converters in a series-parallel connection with both d.c. and a.c. electromagnetic coupling. The differential equations, in operator form, for voltages and currents are solved on a breadboard with the appropriate network of operational amplifiers, without contact elements and semiconductor logic elements. In a typical case of a 3-phase bridge converter the total number of operational amplifiers has been reduced to 13 from the 206 needed for simulation by the conventional method. Special cases are converter systems with electromagnetic coupling on either the a.c. side or the d.c. side only. Calculations of transient currents have been checked against and found to agree within 6% with the results of a physical simulation. Figures 6; references: 7 Russian.
[257-2415]

RESONANCE-TYPE PARAMETRIC INSTRUMENT FREQUENCY CONVERTER

Moscow ELEKTRICHESTVO in Russian No 2, Feb 81 pp 51-53 manuscript received 7 Jan 80

LOKAREV, V. I., Nikolayev Institute of Shipbuilding

[Abstract] Described here is a general-purpose multifunctional device which consists of a single-stage parametric amplifier with current-dependent variable inductances and a balancing circuit, a frequency converter (halver or doubler), and a phase shifter. The amplifier is connected to the busbar of a synchronous generator through a variable resistor. Its performance is optimum with a zero phase shift between input signal and pump signal, the sensitivity being a function of the Q-factor and the frequency deviation, always much higher than that of a plain nonparametric converter. Figures 4; references: 5 Russian.
[257-2415]

AUTODYNE FREQUENCY CONVERTER BUILT WITH AN AVALANCHE-TRANSIT-TIME DIODE

Kiev IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOELEKTRONIKA in Russian Vol 24, No 2, Feb 81 pp 107-109 manuscript received 26 May 80

DANYUSHEVSKIY, Yu. Z. and ROMAN, O. A.

[Abstract] An experimental study was made of a modulator-type autodyne frequency converter with an avalanche-transit-time diode, operating with an input power of the same order of magnitude as the output power of the device operating in the oscillator mode. Measurements were made with harmonic 400-600 MHz signals coming from a standard oscillator through a ferrite rectifier and a low-pass filter with a 3 GHz cutoff frequency. The autodyne included a waveguide resonator tuned to 11,020 MHz and loaded by an absorber. The output signal at an upper intermediate frequency of 11,420-11620 MHz was picked off this resonator. The conversion factor was measured as a function of the input power and as a function of the input signal frequency. Its maximum value, 5.5-6.5 dB, was found to correspond to that in a parametric frequency converter. The maximum power of 50 mW was obtained at the upper intermediate frequency of 11,420 MHz. Instability zones were discovered at input power levels above 30 mW, but could be eliminated by using a regenerative amplifier with an avalanche-transit-time diode and converting its output signal frequency while pumping from an external source at 11,020 MHz. Figures 3; references 5: 2 Russian, 3 Western (one in translation). [236-2415]

UDC 621.385:537.227

PYROELECTRIC MICROWAVE PEAK POWER CONVERTER

Kiev IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOELEKTRONIKA in Russian Vol 24, No 1, Jan 81 pp 81-82 manuscript received 6 Jul 79, after revision 24 Jun 80

KLYUCHNIK, I. I.

[Abstract] A microwave peak power converter for use in channels operating at fixed frequencies is described. The converter consists of a pyroelectric plate based on a single crystal or pyroceramic placed in a rectangular waveguide section so that the receiving electrode, whose thickness is of the same order of magnitude as the depth of penetration of the microwave radiation, is located adjacent to the inner surface of the narrow or broad wall of the waveguide. Shifting of a converter found in the narrow wall by the amount of its thickness into the inside of the waveguide significantly increases the output signal because of direct absorption of the radiation by the pyroelectric material. This brief communication is concerned with the selection of characteristics and dimensions of pyroelectric materials for this purpose and analyzes known methods for suppression of piezoelectric noises: 1) Orientation and attachment of the

specimen in order to assure minimum piezoelectric excitation; 2) Tapping of the signal after a delay; 3) Manufacture of irregular shapes of converters; 4) Use of materials with significant acoustical attenuation; 5) Application of amortization-damper devices; and 6) Use of a compensation circuit. The use of a differential circuit can achieve wideband reception of pulsed microwave radiation in order to allow pyroelectric converters to act as microwave peak power receivers. Figures 1, references: 3 Russian.
[230-6508]

UDC 537.312.62:621.3.013.001.24

CONTROL OF ELECTROMAGNETIC FIELD IN SUPERCONDUCTORS

Moscow ELEKTRICHESTVO in Russian No 1, Jan 81 pp 51-55
manuscript received 11 Aug 80

LUTIDZE, Sh. I., doctor of technical sciences, Moscow

[Abstract] A microscopic nonlocal theory of superconductors is presented which is consistent with the macroscopic properties of such conductors. The theory makes possible a quantitative analysis of the magnitudes connected with these properties in addition to (as a particular case) determination of the known expressions for models of the critical state of a superconductor. Determination of the electromagnetic field in superconductors reduces to Dirichlet's boundary value problems. According to the proposed theory, in addition to the given boundary values of the magnetic field induction on the surface of a superconductor, it is necessary to determine the coefficient of nonlinearity of the magnetic field. The expressions obtained for the nonlocality characteristics of the magnetic field, the effective values of the magnetic susceptibility and the resistivity of the superconductor, as well as the analytical approximations for these magnitudes describe well the properties of a superconductor medium and are convenient for engineering calculations. Figures 2; references 5: 4 Russian, 1 Western.
[235-6415]

**ELECTRICAL ENGINEERING EQUIPMENT AND
MACHINERY: APPLICATIONS AND THEORY**

UDC 538.311.001.57

**SIMULATION OF ELECTRIC FIELDS IN INSULATING GAPS IN ELECTRICAL EQUIPMENT BY
THE METHOD OF ELECTROSTATIC INDUCTION**

Moscow ELEKTRICHESTVO in Russian No 2, Feb 81 pp 49-51 manuscript received 7 Jul 80

BEREZOV, V. A. and IVANOV, S. A.

[Abstract] The method of electrostatic induction, based on the Shockley-Ramo theorem, can be applied to simulation of electric fields in three-dimensional insulating gaps in electrical equipment for design purposes. An electrode system geometrically similar to the object is constructed and a charge is introduced into it. The potential or any component of its gradient can then be determined. This method was tested on an array of electrodes in an air space with boundary conditions duplicating, to the proper scale, those of the original. A piecewise-homogeneous medium was simulated with appropriate dielectrics. A conducting variable-charge vibrator probe was used for simultaneous determination of all three orthogonal components of the potential gradient, through extraction of the individual components of the induced current with frequency and phase selection. Figures 5; references 6: 4 Russian, 2 Western.
[257-2415]

UDC 621.314

HIGH POWER PULSED TRANSFORMER WITHOUT A CORE

Kiev IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOELEKTRONIKA in Russian Vol 24, No 1, Jan 81 pp 96-98 manuscript received 23 Oct 79, after revision 9 Jun 80

VDOVIN, S. S.

[Abstract] It is shown that when a rectangular pulse is transformed to a different voltage with no capacitive coupling between the primary and secondary windings and when certain conditions are fulfilled, the pulse is distorted at the output of the pulse transformer in that the edges are elongated and the voltage at the peak is reduced. When there is capacitive coupling, the dispersion is increased still

further. The usual method of eliminating this problem is to introduce a ferromagnetic core. However, if the pulse transformer is a part of a generator with low internal impedance, a second method can be used. An increase in α in such systems can decrease the distortion of the peak of the pulse, and if insulating materials with small ϵ are used allowing large values of E , the diameter or thickness of the wires of the winding is decreased and the transformer circuit is planned effectively in order to reduce L_p and C_p . Pulse transformers designed by this method were tested and found to be simple to manufacture and satisfactory in operation. Figures 2; references: 3 Russian.
[230-6508]

**INSTRUMENTS, MEASURING DEVICES AND TESTERS, METHODS
OF MEASURING, GENERAL EXPERIMENTAL TECHNIQUES**

UDC 537.311.6

COMPARISON OF VARIOUS IMPEDANCE CHARACTERISTICS OF MEASURING INSTRUMENTS

Moscow ELEKTROSVYAZ' in Russian No 2, Feb 81 pp 21-23
manuscript received 12 Feb 80

MEDVEDEV, Yu. A. and KARABANOV, V. A.

[Abstract] As a basis for comparison shopping, selection, and application, relations are established for various impedance characteristics, as defined by Soviet and foreign manufacturers of measuring instruments for the communication industry. These characteristics are the frequency-dependent mismatch attenuation, reflection coefficient (its modulus), traveling-wave ratio and standing-wave ratio. Formulas and graphs are available for finding the values of these quantities. Seventy-five ohms has been chosen as the ideal nominal load resistance. The stray capacitance, in parallel with the load or across the input, will depend at any given frequency and mismatch attenuation level on the deviation of the real resistance from the nominal one. Figures 1; references: 3 Russian.
[258-2415]

UDC 543.46

**METHODS OF INFRARED INTERFEROMETRY FOR MEASURING THE PARAMETERS OF EPITAXIAL
SILICON STRUCTURES WITH A LATENT LAYER**

Moscow MIKROELEKTRONIKA in Russian Vol 10, No 2, Mar-Apr 81 pp 140-145
manuscript received 17 Oct 79

BANKOVSKIY, Yu. V., VOLKOVA, L. V., KOKIN, A. A., LONSKIY, E. S. and RAKOV, A. V.

[Abstract] Almost all silicon structures for modern integrated microcircuits contain a latent layer, which requires special method of process analysis and product quality control. The depthwise distribution of impurity concentration and correspondingly of current carriers is the main characteristic of such a layer, which is in turn characterized by a few parameters such as the maximum impurity concentration and the distance from the plane of maximum impurity concentration to the surface. One method of determining this distance, or thickness,

in epitaxial structures with such a layer is by processing of infrared interference spectra of reflection. Conventional processing of such spectra in the 8-25 micrometer range of wavelengths according to the single-layer model for n-n⁺-p structures with a high impurity concentration have been found to be very inaccurate when checked against other methods of thickness and impurity concentration measurement. Therefore, the method is broadened here to include multiple reflections by both wafer surfaces and single reflections by the front surface and the back surface of the latent layer, also including absorption in the lattice as well as by free carriers and scattering by random inhomogeneities. Two corresponding reflection coefficients are calculated accordingly, and from adjacent zero cross-overs of their difference the layer thickness is then determined. This method is also applicable to silicon structures with a dull passive back surface. It extends the interference method to structures with impurity concentrations higher than $2 \cdot 10^{18} \text{ cm}^{-3}$ in the latent layer and accurately, within 0.2 μm , relates the layer thickness to a precisely defined point on the impurity concentration profile. Figures 4; tables 1; references: 3 Russian. [238-2415]

UDC 621.3.042:621.382.6

SELECTION OF MAGNETIC CIRCUITS FOR DEVICES WITH HALL-EFFECT PROBES

Moscow ELEKTRICHESTVO in Russian No 2, Feb 81 pp 69-71
manuscript received 9 Jun 80

NAZAROV, P. A., candidate of technical sciences, and ABLAYEV, A. T., engineer,
Turkmen Polytechnic Institute

[Abstract] A compensation method of eliminating the temperature drift of the Hall emf in precision instruments is proposed which involves matching the temperature characteristics of the galvanomagnetic elements with those of the ferromagnetic components. The rates of change of the magnetic induction and of the Hall coefficient must be of opposite signs. The method is demonstrated on a semiclosed magnetic core with a winding connected to a current source and with a Hall probe in the narrow gap, also on an amplifier-concentrator of magnetic induction. With the aid of the design formulas, it is shown that using the proper grade of ferrite core material will reduce the temperature drift of the Hall coefficient to within 0.15%/°C over the (-40)-(+120)°C range. The method is simple and requires no additional temperature-compensation elements. Figures 3; tables 2; references 5: 4 Russian, 1 Western. [257-2415]

LOW-FREQUENCY NOISE IN HOT CARRIER DETECTORS

Kiev IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOELEKTRONIKA in Russian Vol 24, No 1, Jan 81 pp 75-78 manuscript received 14 Sep 79

IVANOV, N. I. and PET'KOV, G. V.

[Abstract] This work analyzes the low-frequency noise of hot carrier detectors. Low-frequency electrical fluctuations in electromagnetic radiation detectors are described by the relative noise temperature. The fluctuation properties of hot carrier detectors are determined by thermal, shot and flicker noise and the noise which arises in the input wave guide. The contribution of each noise source to the signal-to-noise ratio is determined. Experimental results indicate that hot carrier detectors can be used for the creation of low-noise electromagnetic radiation detectors for the centimeter and millimeter wavebands with characteristics satisfactory for many applications in electronic and measurement technology.

Figures 1; references: 4 Russian.

[230-6508]

APPLICATION OF THE LASER SCANNING METHOD TO DETECTION OF DEFECTS IN EPITAXIAL STRUCTURES WITH LATENT LAYERS

Moscow MIKROELEKTRONIKA in Russian Vol 10, No 2, Mar-Apr 81 pp 146-152 manuscript received 13 Dec 79

ANGELOVA, L. A., KOZLOV, A. Yu. and V. V. SKRIPKO

[Abstract] Epitaxial silicon structures with latent layers have found wide use in modern integrated microcircuits. As the level of integration increases, the danger also increases of local diffusion regions merging and the integrated circuit becoming defective. Nowadays such defects are detected either by chemical etching or by electrical measurements. Here a nondestructive photoelectrical method is proposed which involves scanning the inspection sample with a focused laser beam and recording the photo-emf or the photocurrent at each point. The mechanism of the photoelectric effect between upper and lower surface of a wafer is explained with the aid of an equivalent of the structure, a $p-n^+-p$ one or an $n-n^+-p$ one, containing two local n^+ type diffusion regions of a latent layer and respectively a p -type or an n -type epitaxial layer on a p -Si single crystal as the substrate. The readings are based on the dependence of the photo-emf or the photocurrent in the load resistance on the parameters of this equivalent circuit and, accordingly, an expression for the signal current is derived from the circuit equations. A probe and a test cell have been developed, the former leaving a trace on the wafer surface and the latter impressible into each operating wafer. Typical video and photo images of defective structures are shown. The same apparatus is suitable for detection of other defects such

as irregular boundaries caused by flaws in the raw material (silicon substrate) or photolithographic ones. An important advantage of this method over electrical measurements is that merging of local diffusion regions can be detected during earlier stages of the manufacturing process. Figures 6; references: 1 Russian. [238-2415]

EXPERIENCE IN OPERATING THE PIC-PI,PS CABLE-EMBEDMENT-DEPTH METER

Moscow VESTNIK SVYAZI in Russian No 2, Feb 81 pp 23-24

SMIRNOV, G. V., senior engineer, Laboratory, Territorial Center, of Interurban Communications and Television Management No 3

[Abstract] It has been established statistically that most damages to communication cables caused by extraneous excavation and construction activities occur at small embedment depths. An instrument, the PIC-PI and PS, has been developed at the Kiev Affiliate of the Central Scientific-Research Institute of Communication and built at the Laboratory of the Territorial Center of Interurban Communications and Television Management No 3 which facilitates discrete measurements as well as continuous inspection of the cable embedment depth, with a $\pm 6\%$ error over the 0-150 cm range and with a $\pm 10\%$ error over the 0-300 cm range, as well as tracing the cable route and accurate fault location. It consists of a searcher with a conventional KI-4 oscillator and a pickup, the oscillator delivering an adequate power of 2 W and operating without frequency adjustment for one whole day. The instrument operates at temperatures from -10 to $+40^{\circ}\text{C}$. It has been field tested by teams of either four or five persons along a 6460-km long line which was laid in 1950 and a 228-km long line laid in 1965. Both selective and continuous measurements have yielded satisfactory cartograms of cable embedment and have properly revealed vulnerable spots of small embedment depth. The instrument, which is now series-produced, should contribute to a more reliable operation of cable lines. Figures 1. [259-2415]

CIRCUIT ENGINEERING STRUCTURAL SYNTHESIS OF ELECTRONIC LOGIC CIRCUITS

Moscow MIKROELEKTRONIKA in Russian Vol 10, No 2, Mar-Apr 81 pp 163-177
manuscript received 5 Aug 79

GLORIOZOV, Ye. L., Moscow Institute of Electronic Machinery

[Abstract] The concept of circuit engineering structural synthesis is applied to logic circuits from the standpoint of the labyrinth theory. The problem is formulated in terms of a space of variables consisting of four sets (set of states, set of initial states, set of final states, set of operators) and five elements (device base, discrete computer medium, state of the latter and of the circuit realization, operator of transformation from one circuit to state to another, distinction measure in terms of optimality criteria. The algorithm of structural synthesis is described completely by the operator, the state and the target function. One important step is defining and selecting the target functions, then reducing their number, which is done with a "generator of plausible circuits" and a search tree. The selection process by complete sorting can be shortened appreciably either by programming or by using the W-matrix of straps. Here the problem of synthesis is formulated as an extremal problem of combinational programming with a finite number of elements in a given set of combinations. The search tree is shortened by "growing" the logic structure or by using a "tree of leading criteria", both narrow-beam search methods. Standard procedures used in the algorithm of structural synthesis include the ER-synthesis, the parametric opt(ξ_1)-synthesis, generalization of the initial approach, the "shake-up" procedure, and "generation and growing" of a new solution. Figures 6; references 13: 12 Russian, 1 Western (in translation).
[238-2415]

METHOD OF TEMPERATURE-STABILIZING THE LUMINOUS CHARACTERISTICS OF OPTOELECTRONIC DEVICES

Moscow RADIOTEKHNIKA in Russian No 2, Feb 81 pp 78-82
manuscript received after completion 15 Jan 80

PLYUT, A. A. and MATYUNIN, S. A.

[Abstract] The characteristics of optoelectronic devices include a poor temperature stability, which greatly impedes progress in the application of these devices. None of the known stabilization methods, except thermostatic control, is universal. The dark characteristics, but not the luminous characteristics, can be easily temperature-stabilized by means of appropriate circuits. Here, matching the corresponding parameters of the radiation source and of the photoreceiver, particularly of their temperature-dependent integral sensitivity, is considered as a method of stabilization. This involves the use of filters: monochromatic, band, short-wave cutoff and long-wave cutoff filters, depending on the spectral characteristics of the source and the receiver. As an example, a monochromatic interference-type light filter consisting of SbS_3 and SrF_2 layers is designed for stabilizing the characteristics of a FT-2K photoresistor illuminated by a type-A source. Figures 2; tables 1; references: 6 Russian.
[240-2415]

THYRISTOR-MAGNETIC GENERATOR OF HIGH-FREQUENCY PULSES

Moscow RADIOTEKHNIKA in Russian No 2, Feb 81 pp 39-41
manuscript received 2 Jan 80

MESHKOV, A. N. and SHISHKO, V. I.

[Abstract] A compact oscillator is described capable of generating up to 10 MW pulses of a duration down to 1 ns with a repetition rate up to 20 kHz, for use in radar as well as accelerator and laser systems. It consists of two intertype pulse generators with power thyristors and saturable reactors, diodes and capacitors, a pulse shaping line, and a ferrite distribution commutator across the load. The thyristors are switched on sequentially for relatively long periods of time so as to reduce the switching losses. The oscillator components can be optimized with respect to the steady-state oscillation mode and the switching transient. A 300 V-20 kHz-0.8 MW-50 ns oscillator has been built and tested. It contains TCh-63 thyristors which conduct for 15 microsecond and M600NNK annular ferrite cores. Figures 1; references: 6 Russian.
[240-2415]

PHOTOELECTRIC PHENOMENA AND DEVICES,
ELECTROLUMINESCENCE, ION DEVICES

UDC 621.383

THEORETICAL ANALYSIS OF A PHOTODETECTOR BASED ON AN N-P-N DEVICE WITH CHARGE COUPLING

Moscow MIKROELEKTRONIKA in Russian Vol 10, No 2, Mar-Apr 81 pp 118-126
manuscript received 5 Aug 79

KHAYNOVSKIY, V. I. and NOVOZHILOVA, N. S.

[Abstract] Photorelaxation in a bulk device for a photodetector and an image converter with charge coupling is analyzed on the basis of a one-dimensional physical model of an n-p-n structure on a p-type substrate. First the potential distribution, as well as the minimum potential and the maximum potential attainable in the p-region and in the bulk n-region, respectively, are determined from the solution to a Poisson equation. Then the rates of change of photohole and photoelectron concentrations under the corresponding electrode pairs are determined, changes in concentration caused by fundamental absorption of radiation, with the voltages at the three electrode pairs different so as to form a step-wave potential distribution. The photosensitivity spectra of all three channels, surface n-region and bulk n-region as well as intermediate p-region, were calculated by a numerical solution of the corresponding not analytically solvable equations. Here results are shown for a silicon device and for a GaAs device over the 0.4-1.0 micrometer range of absorbed wavelengths. Figures 6; references 14: 3 Russian, 11 Western (one in translation).
[238-2415]

POWER SYSTEMS (INCLUDING EFFECT OF
VARIOUS ITEMS ON POWER TRANSMISSION)

UDC (621.316.925.2:621.315.1.027.3).001.24

ALGORITHMS AND PROGRAMS OF OPERATION OF MEASURING ELEMENTS IN DISTANCE RELAYING
PROTECTION FOR 330-750 kV OVERHEAD TRANSMISSION LINES

Moscow ELEKTRICHESTVO in Russian No 2, Feb 81 pp 15-21
manuscript received 11 Jul 80

ZISMAN, L. S., Moscow

[Abstract] On request by the Central Dispatch Management in the USSR Unified Power System, a distance relaying system for protecting overhead transmission lines against phase-to-phase short circuits has been developed at the All-Union Scientific Research Institute of Electric Power. Its novelty is that it contains two types of measuring elements which operate according to different algorithms so as to ensure both a faster response in the case of a near fault and a better accuracy in the case of a far fault. The program of protective distance relaying is implemented by an M-6000 control minicomputer within fixed time intervals up to 100-150 ms after a fault has occurred, voltages and current serving as the input data fed to the memory through analog-to-digital converters (output 12 bits, accuracy within 0.1% with 1.667 ms quantization intervals. The performance of both measuring elements, one with digital differentiation and one with digital filtration by the convolution method using orthogonal trapezoidal functions, is matched to the relations in the equivalent circuit diagram of the transmission line and formalized in respective algorithms for programming the operation. The programs for both types of measuring elements have been tested on a substation computer over the 1-100 V and 0.1-10 A ranges, with an evaluation of errors and stability during 5% frequency fluctuations, for protection of a 157 km long 330 kV transmission line. Figures 8; tables 1; references 9: 4 Russian, 5 Western (one in translation).
[257-2415]

SINGLE-STAGE REGENERATIVE PULSE DRIVERS BASED ON HIGH-POWER MOS TRANSISTORS

Leningrad IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: PRIBOROSTROYENIYE in Russian
No 1, Jan 81 pp 70-74 manuscript received 25 Mar 80

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recommended by the Department of Industrial Electronics

[Abstract] Because MOS transistors have a faster rise time for a switched current, a higher input impedance and a smaller switching delay than their bipolar counterparts with the same power ratings, they are promising for pulse driver applications. This article analyzes MOS pulse drivers which share the common feature of a pulse transformer in the feedback circuit, but which differ in the location of the timing capacitor in the positive feedback circuit. It is assumed that: 1) The MOS transistor is turned on and off instantaneously; 2) The primary winding magnetization current of the pulse transformer is zero; and 3) The resistance in the gate circuit of the field effect transistor, referenced to the transformer primary, is an order of magnitude less than the load resistance. Three simple one-transistor pulse driver designs are considered: 1) A pulse driver with the timing capacitor in the output circuit of the pulse autotransformer; 2) A pulse generator with the timing capacitor in the primary winding of the pulse transformer; and 3) A pulse driver with the timing capacitor in the input circuit of the pulse transformer. The MOS device is a KP901A transistor operating with a supply voltage of 27 volts. The experimental check of the circuits produced pulse widths of 10, 1.4 and 1.6 microseconds, respectively. The voltage amplitude in the load was 22 volts, the rise time was on the order of 30 nanoseconds with a decay time of 50 nanoseconds. A comparison of the results calculated from the simple expressions proposed and the experimental values shows good agreement. Figures 3; references: 4 Russian.

[213-8225]

UDC 621.373.825

INFLUENCE OF INDUCED BIREFRINGENCE ON THE GENERATION OF POLARIZED LIGHT BY A NEODYMIUM GARNET CW LASER

Leningrad IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: PRIBOROSTROYENIYE in Russian No 1, Jan 81 pp 84-89 manuscript received 11 Nov 79

GOLYAYEV, Yu. D., YEVTYUKHOV, K. N. and KAPTSOV, L. N., Moscow State University, recommended by the Department of General Physics and Wave Processes

[Abstract] The optimal mutual positioning of the active elements and the intra-resonator polaroid for a Nd:YAG laser is found by means which analytically solve the problem of the impact of the birefringence induced in the active elements on the lasing efficiency. The analytical expressions describe the distribution of the birefringence over the cross-section of a garnet laser rod, taking into account the anisotropy in the elastic properties of the garnet. It is assumed that the length of the element lines up with the [001] axis and the temperature is constant over the entire side surface. The expression derived for the characteristic describing the depolarizing effect of the induced inhomogeneous birefringence is checked experimentally by measuring the residual light flux level, i. e., the ratio of the light flux power passing through crossed polaroids with the active elements placed between them, to the light power passing through the first polaroid. The check employed an LG-38 laser and the linear polarization was converted to circular by a quarter-wavelength plate. The polarizer could be rotated together with the crossed analyzer in order to determine the residual light flux level as a function of the direction of polarization of the light incident to the active element. A telescope was used to ascertain the central region of the probe beam and the measurements were made with an active element spot 3 x 65 mm. The agreement between theory and experiment is good and it is shown that optimizing the position of the polaroid substantially boosts the efficiency of the generation of polarized light. The gain achieved by such optimization is reduced lasing elements are used which have a high initial stress. The residual light flux is plotted as a function of the position of the polarization plane of the incident light relative to the [100] axis, as well as a function of the absorbed pumping power. Figures 3; tables 1; references 8: 4 Russian; 4 Western.
[213-8225]

BRIEFS

LASER SPRAYER--The laser beam has become an unusual brush, capable of applying a molecule-thin protective layer of polymer on a product. This technology was developed by scientists of the Scientific Research Institute of Mechanics of Metal-Containing Polymer Systems of the Belorussian Academy of Sciences. This development opens new opportunities for improving the quality of microelectronic gear. The scientists established that chains of molecules, under the influence of laser radiation, cover the surfaces of parts as an extremely thin uniform layer. [Text] [Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 21 Apr 81 p 2] 7872

CSO: 1860/245

SEMICONDUCTORS AND DIELECTRICS,
CRYSTALS IN GENERAL

UDC 537.222.2:621.382

STEADY-STATE DISTRIBUTION OF UNCOMPENSATED MOBILE CHARGE IN A 2-LAYER DIELECTRIC

Moscow MIKROELEKTRONIKA in Russian Vol 10, No 2, Mar-Apr 81 pp 132-134
manuscript received 16 Jan 79

ROMANOV, V. P. and CHAPLYGIN, Yu. A.

[Abstract] The steady-state distributions of charge concentration, electric displacement, electric field intensity and electric potential in a 2-layer dielectric medium are calculated from the second-order differential equation for the electric displacement, one dimensional in the direction normal to the boundary between the layers, with the dielectric constant of vacuum and the temperature potential in the coefficient of the second-degree term. The dielectric permittivity, uniform in each medium, is assumed to change stepwise in the form of a Dirac function at their boundary. Integration of this equation yields integrals from which the distribution of electric displacement along the normal coordinate and then successively the other said distributions can be evaluated. Figures 2; tables 1; references: 4 Western (one in translation). [238-2415]

UDC 621.382

SOME PROPERTIES OF InSb-(PLASMOCHEMICAL)SiO₂ STRUCTURES

Moscow MIKROELEKTRONIKA in Russian Vol 10, No 2, Mar-Apr 81 pp 178-180
manuscript received 25 Jan 80

VOLOSOV, A. V., KUTUZOV, M. K., NEUSTROYEV, S. A., RASKIN, A. A. and SOKOLOV, Ye. B.

[Abstract] Plasmochemical deposition is an effective low-temperature method of producing dielectric layers. This method was applied to InSb-(plasmochemical)SiO₂ layers at 100-300°C, with a heater above the substrate holding a grounded electrode and a 13.56 MHz voltage electrode under it. Both p-InSb and n-InSb substrates with (111)B orientation were used. The breakdown electric field intensity varied over the $(1-3) \cdot 10^6$ V/cm range and the dielectric permittivity varied over the

3.7-4.1 range. Current-voltage characteristics at frequencies from 10^2 to 10^5 Hz were plotted and the density of surface states in structures with hysteresis was calculated according to the Nakagawa-Fujisada formula for the top frequency of 10^5 Hz. The data indicate that defects produced in the structure by a high-frequency discharge plasma become annealed at the given deposition temperatures. They also indicate that structures produced at a higher temperature and a lower discharge power have a lower concentration of generation-active radiation centers. A distinct feature of the capacitance-voltage characteristics are peaks which become sharper at lower frequencies, probably caused by the two monoenergetic levels of surface states within the upper half of the forbidden band of InSb. Figures 3; references 12: 6 Russian, 6 Western.
[238-2415]

CSO: 1860

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